Appendix F.2

Water Resources

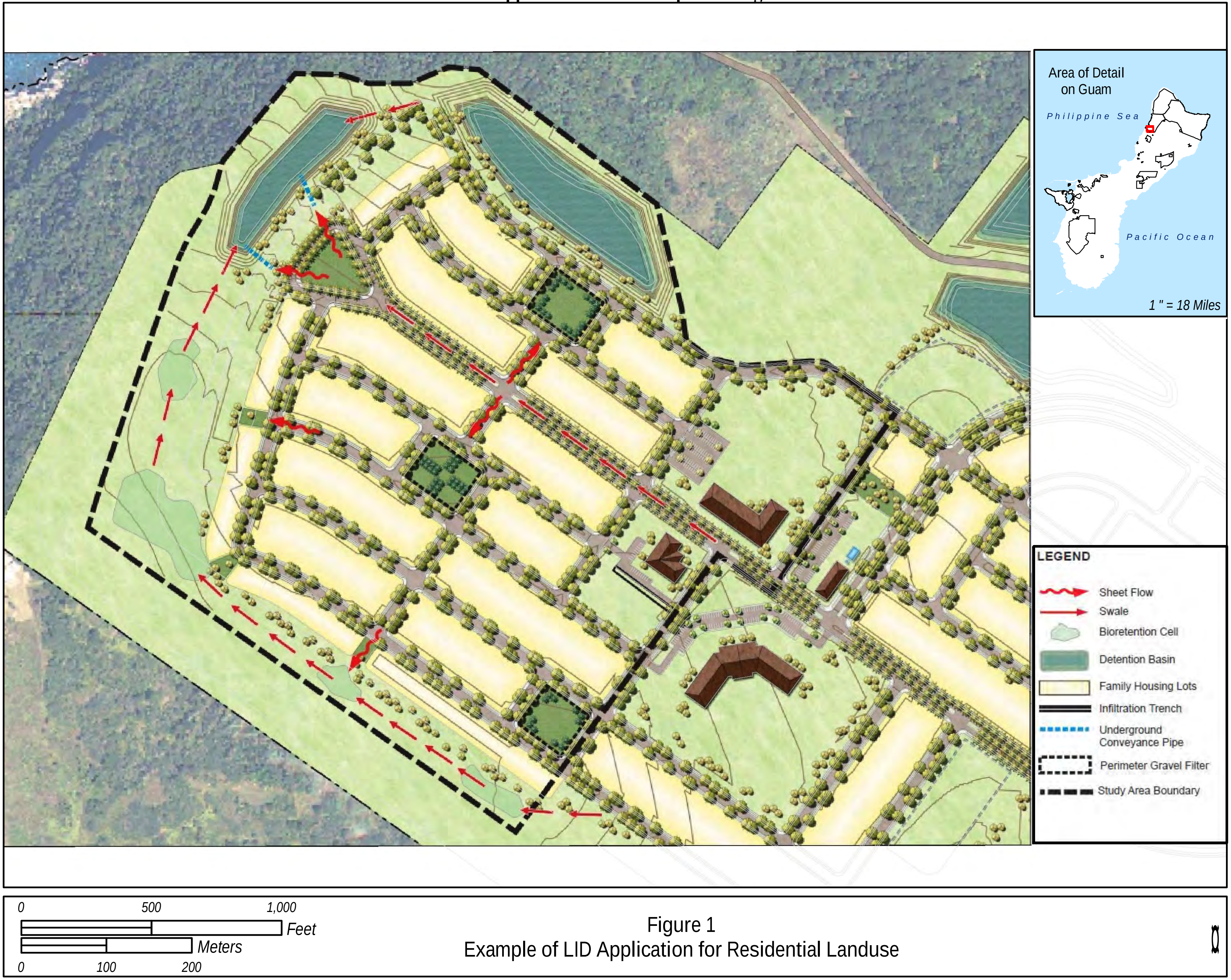


Figure 1
Example of LID Application for Residential Landuse

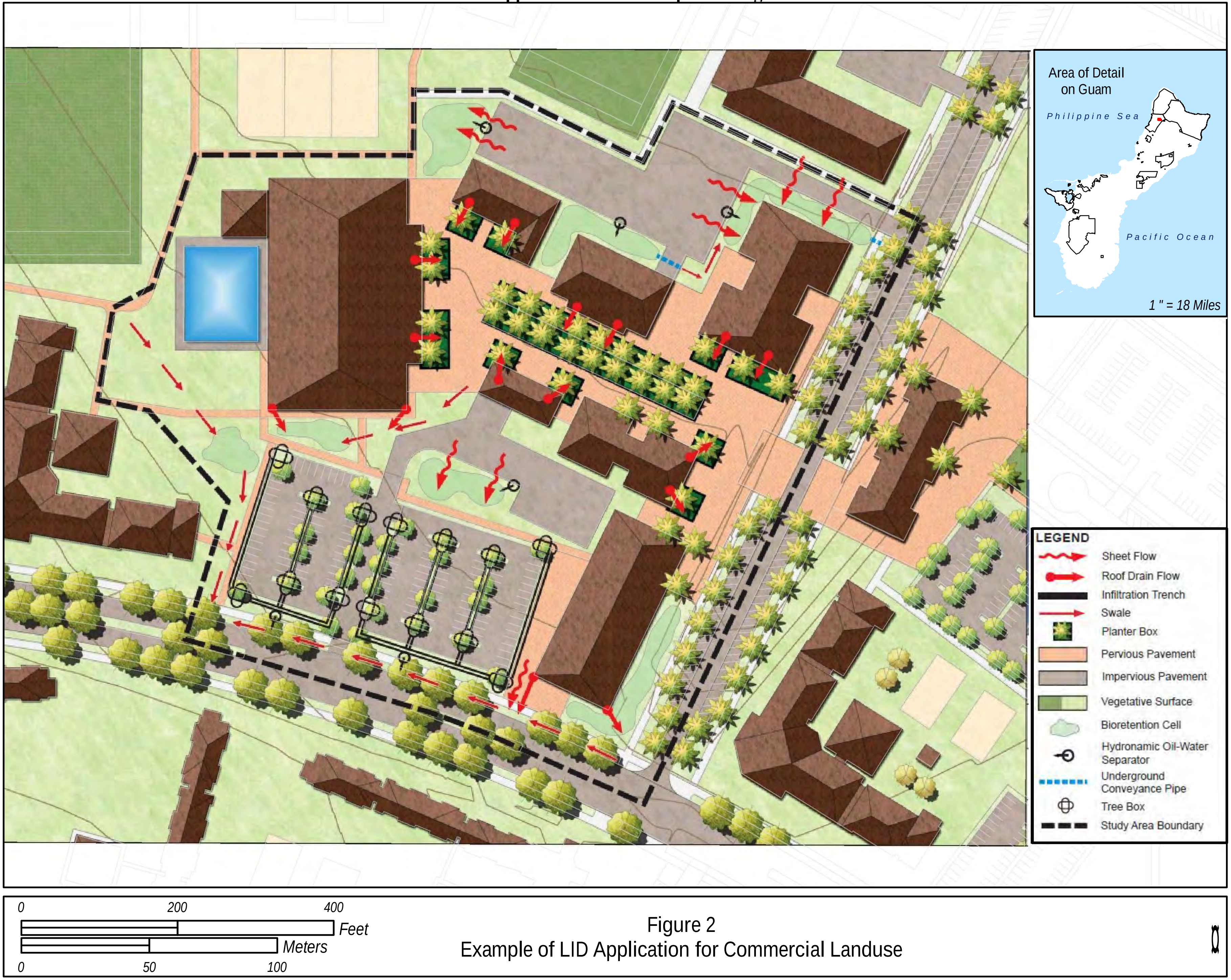


Figure 2
Example of LID Application for Commercial Landuse

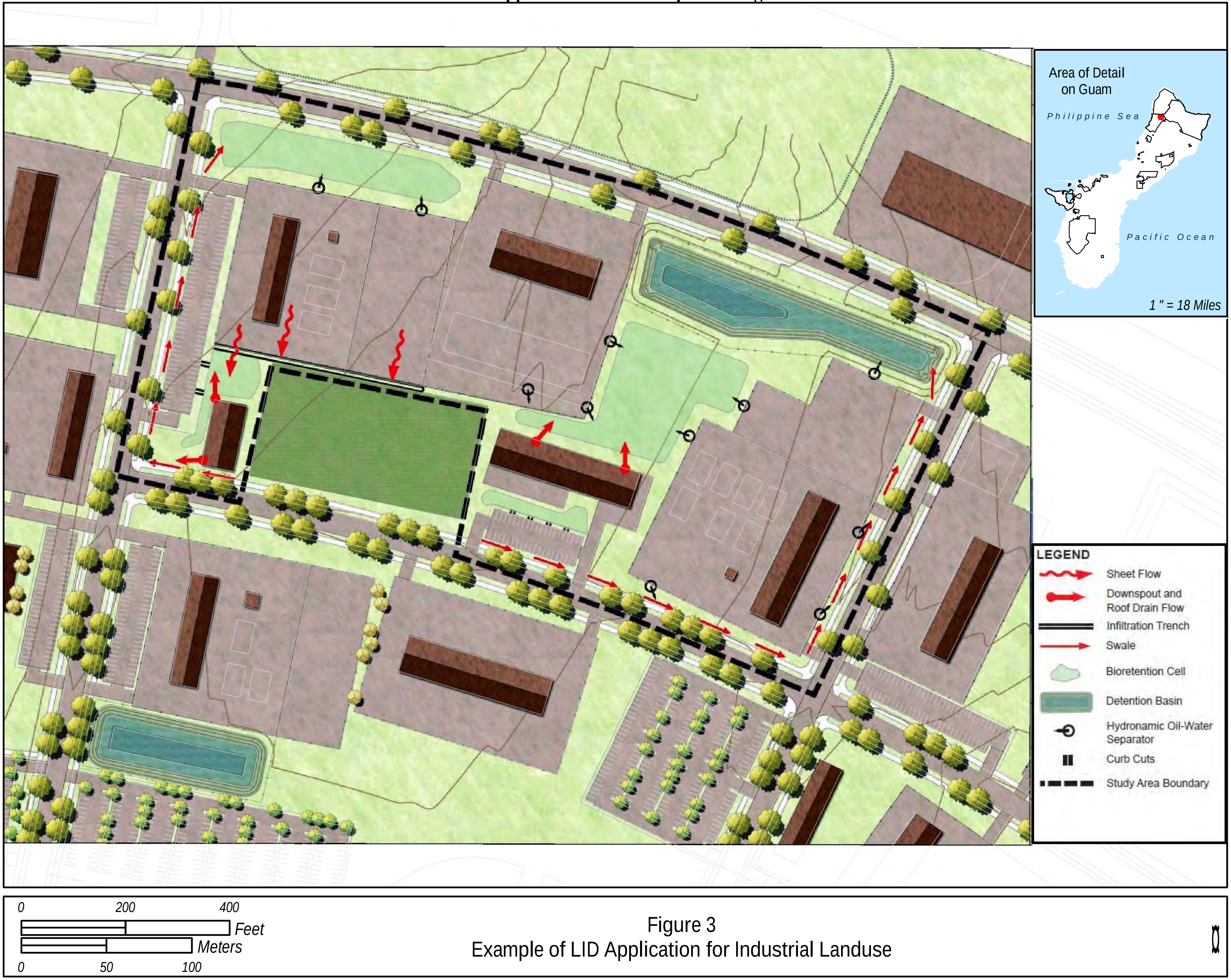


Figure 3
Example of LID Application for Industrial Landuse

Dry Wells

A dry well is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from a variety of sources (e.g., rooftop drains). Water quality from rooftops is generally higher than stormwater quality from surface drainage, resulting in a higher quality of infiltrated water. Roof leaders usually connect directly into the dry well, which is commonly an excavated pit filled with uniformly graded aggregate open to non-compacted native soil. Dry wells discharge the stored runoff via infiltration into the surrounding soils. In the event that the dry well is overwhelmed in an intense storm event, an overflow mechanism (e.g., surcharge pipe, splash pad, connection to larger infiltration area, etc.) would ensure that additional runoff is safely conveyed downstream.

Dry wells can effectively reduce the increase in post-development runoff volume produced during small-and moderate-sized storms. These devices are not intended to provide much removal of coarse particulate pollutants; however, fine particulates and soluble pollutants are effectively removed after exfiltrating through the dry well and into the soil. Subsurface stormwater infiltration Best Management Practices (BMPs) such as dry wells, are approved for use in the *CNMI and Guam Stormwater Management Manual.*[1]

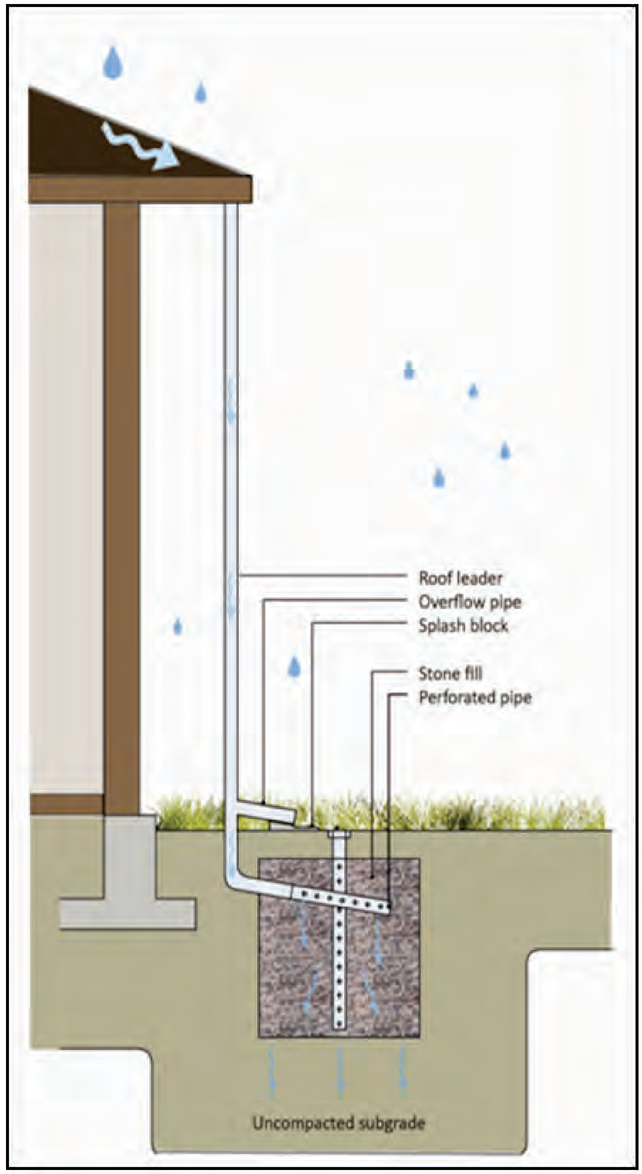


Figure 4: Dry Wells[2]

[1] Horsley Witten Group, Inc. 2006. CNMI and Guam Stormwater Management Manual. Volumes I & II. Final. October.
[2] NAVFAC Pacific. 2010. Final Comprehensive Drainage and Low Impact Development Implementation Study, Finegayan Main Cantonment Area, Guam. Prepared by TEC Inc. Joint Venture (A Joint Venture of TEC Inc., AECOM TS Inc., and EDAW, Inc.). April.

Dry Vegetated Swales

Dry swales are linear and planted open channels, usually designed for stormwater conveyance. However, they can be designed specifically for treatment as well. Dry treatment swales offer both conveyance capacity as well as water quality enhancement. Dry treatment swales commonly have a lower slope gradient (<1%) than conveyance systems with permeable soil or under-drain systems, or with larger vegetation or check dams to slow the flow of water. Dry swales can also provide conveyance and pretreatment by sediment removal while directing water to a storage, treatment, or infiltration facility. Check dams may be located within the swale to enhance storage capacity or reduce flow velocities on steep sites. Vegetation should be tolerant of periodic inundation and water velocity.

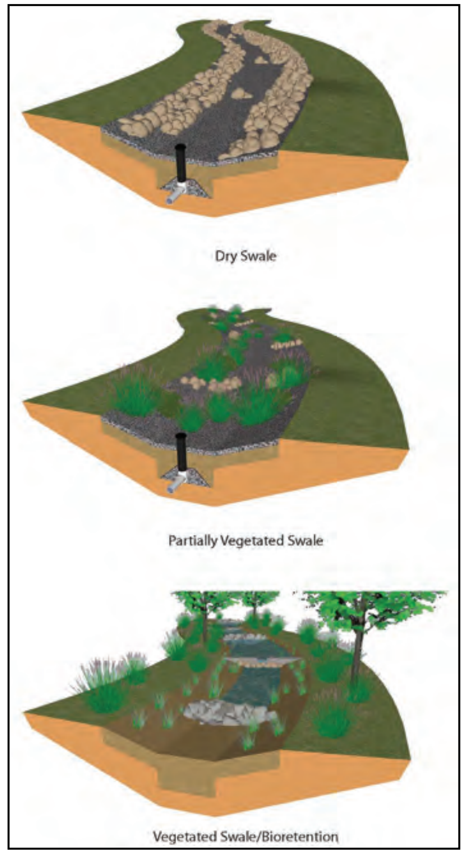
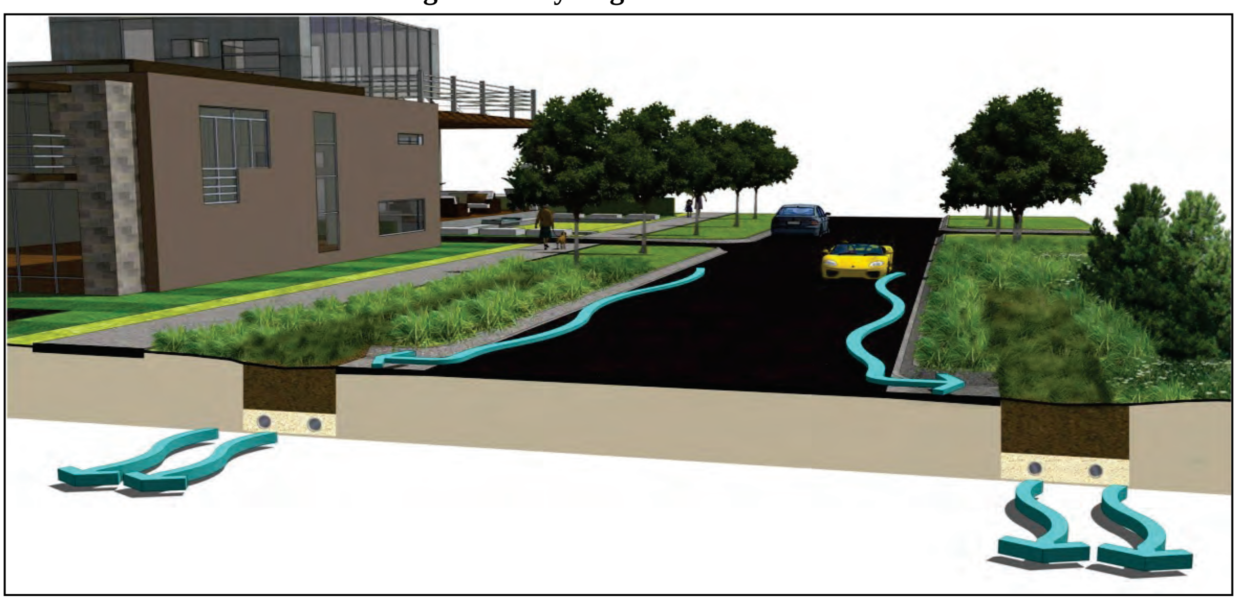


Figure 5: Dry Vegetated Swales[3]



[3] NAVFAC Southwest. 2013. Final Stormwater Conveyance Engineering Study, Camp Del Mar (21 Area). Prepared by AECOM. February.

Gravel Infiltration

Subsurface infiltration systems are typically used where limited open area is available for stormwater infiltration or the use of open detention ponds is not appropriate. The use of infiltration systems is expensive and subject to permitting. Infiltration systems will be minimized and primarily used when other BMPs cannot be implemented, primarily due to space requirements. Subsurface infiltration systems may require an Underground Injection Control Permit from GEPA. The systems are constructed under paved areas and active open areas where standing water is not desired, yet infiltration into the groundwater is the desired result for stormwater management. Stormwater is pretreated to reduce sediment loading using structural BMPs to reduce long-term maintenance.

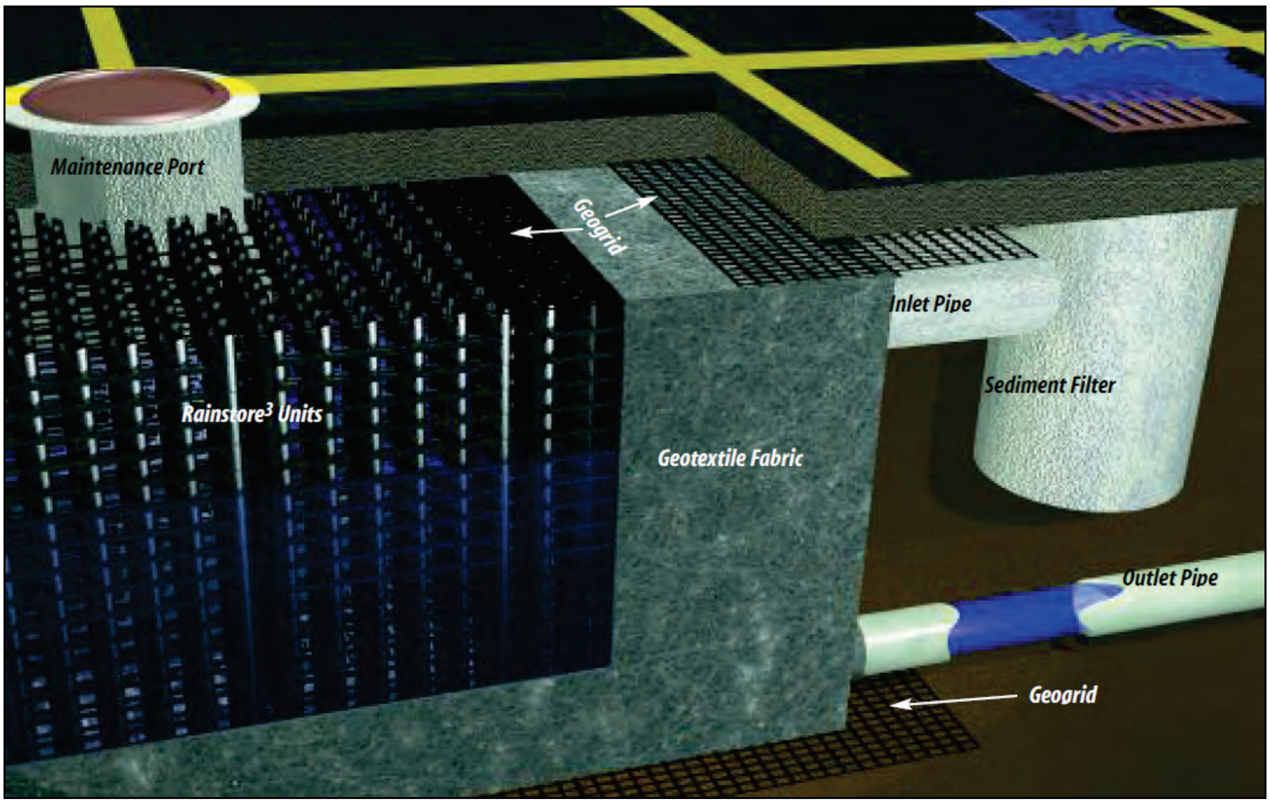


Figure 6: Gravel Infiltration[4]

[4] Invisible Structures, Inc. n.d. Typical Rainstore3 Detention System. Available at: http://www.invisiblestructures.com/rainstore3_whole_system.html.

Bioretention Cell

Bioretention basins are shallow, planted stormwater facilities that rely on plants and soil to treat stormwater. They are often constructed using engineered soils, specifically designed to maximize water quality improvement, and minimize clogging. The plant species must be tolerant of periodic inundation, and some are better than others at removing pollutants.

Bioretention facilities can either allow for infiltration into the native soils, or be designed with an under-drain system to pipe treated water to the stormwater drain system or a surface water body. Due to the high infiltration rates typically found in Guam's soils, it is not expected that these systems will require under-drain piping. An overflow system should be incorporated into the design in the event of storms greater than volume capacity. They can take many aesthetic forms or sizes, fitting in to any type of formal or informal landscape.

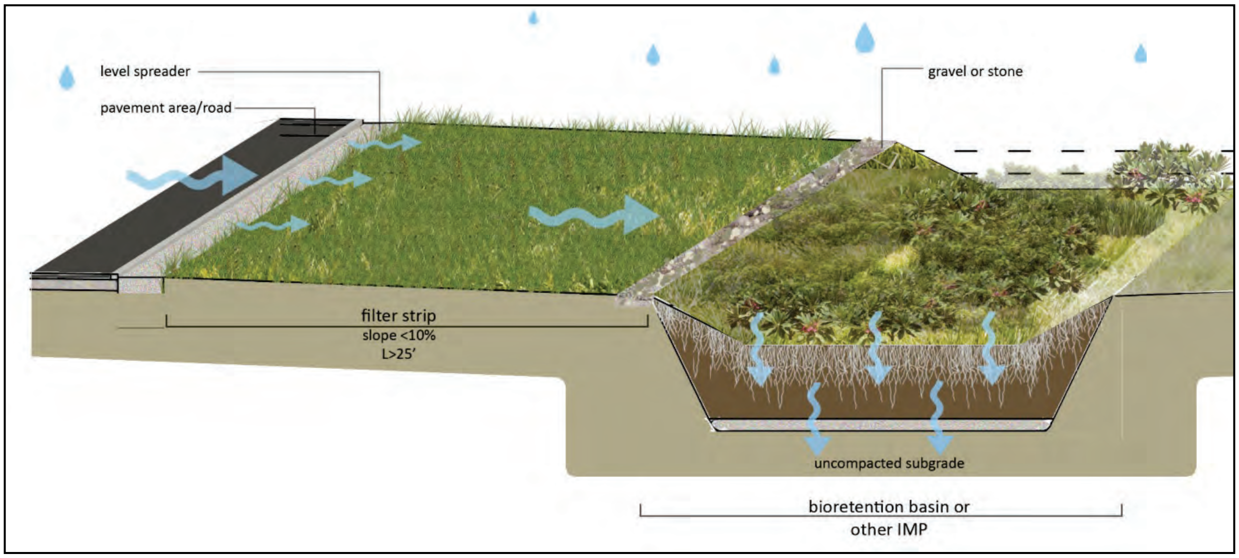


Figure 7: Bioretention Cell[5]

[5] NAVFAC Pacific. 2010. Final Comprehensive Drainage and Low Impact Development Implementation Study, Finegayan Main Cantonment Area, Guam. Prepared by TEC Inc. Joint Venture (A Joint Venture of TEC Inc., AECOM TS Inc., and EDAW, Inc.). April.

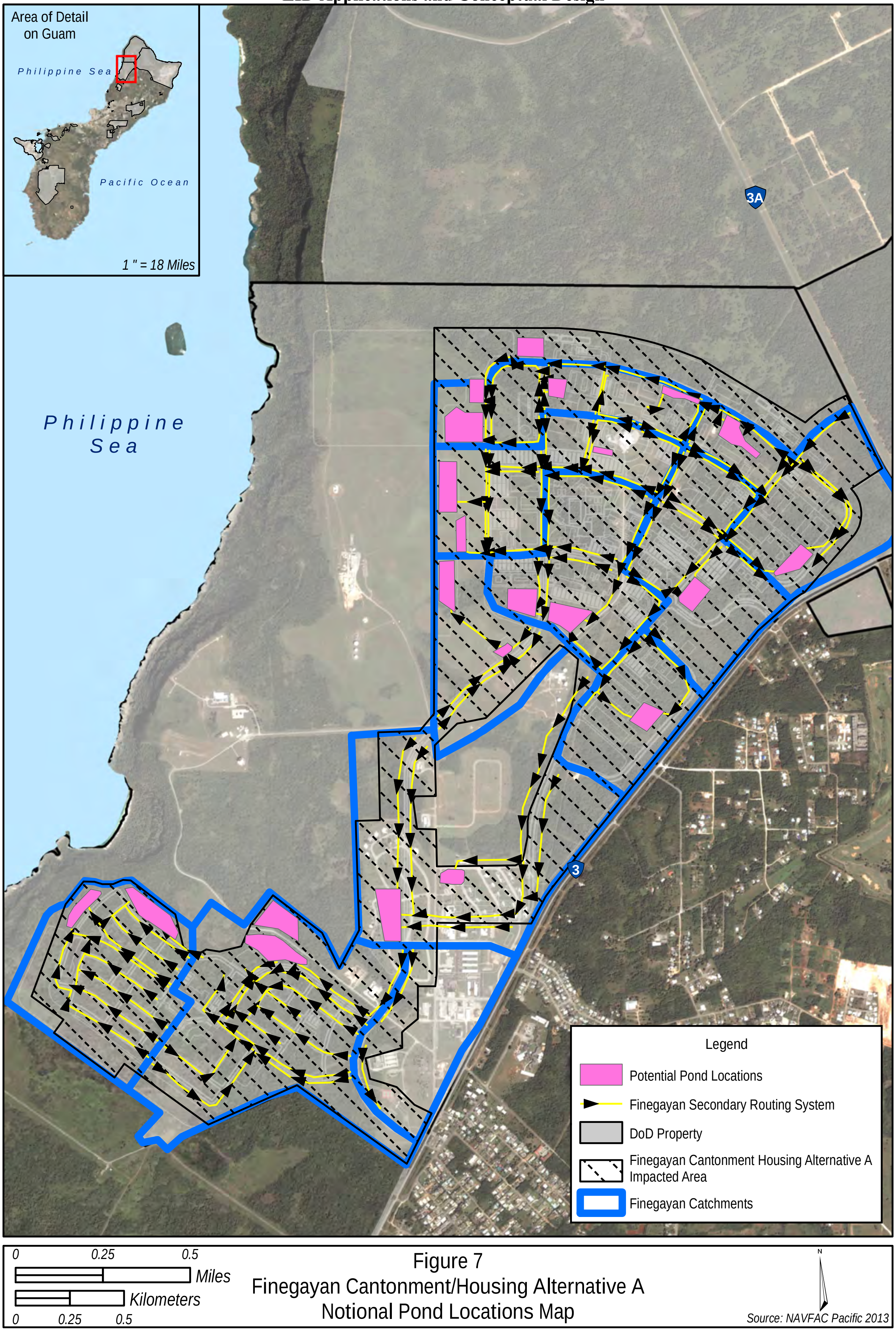


Figure 7
Finegayan Cantonment/Housing Alternative A
Notional Pond Locations Map

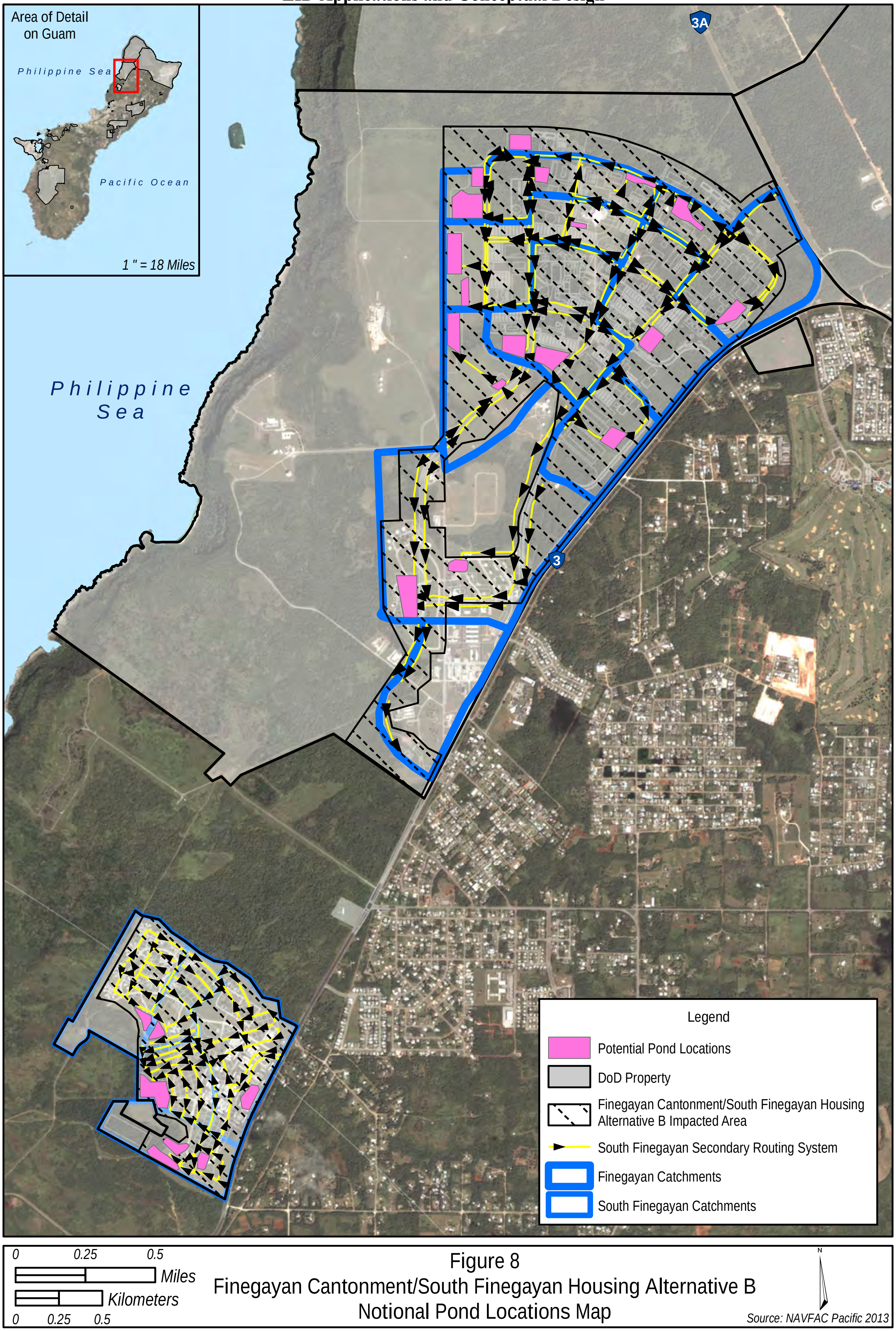


Figure 8
Finegayan Cantonment/South Finegayan Housing Alternative B
Notional Pond Locations Map

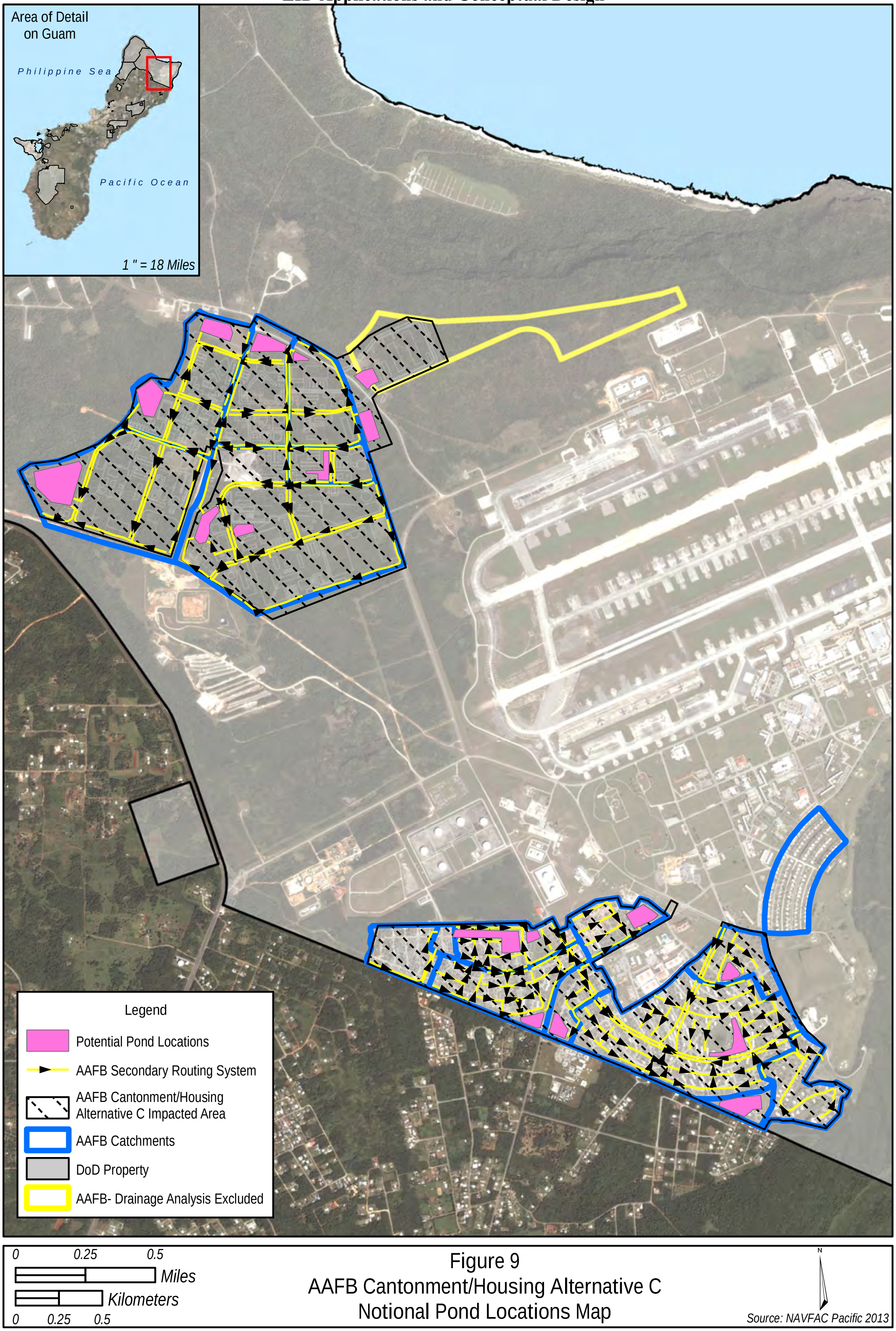


Figure 9
AAFB Cantonment/Housing Alternative C
Notional Pond Locations Map

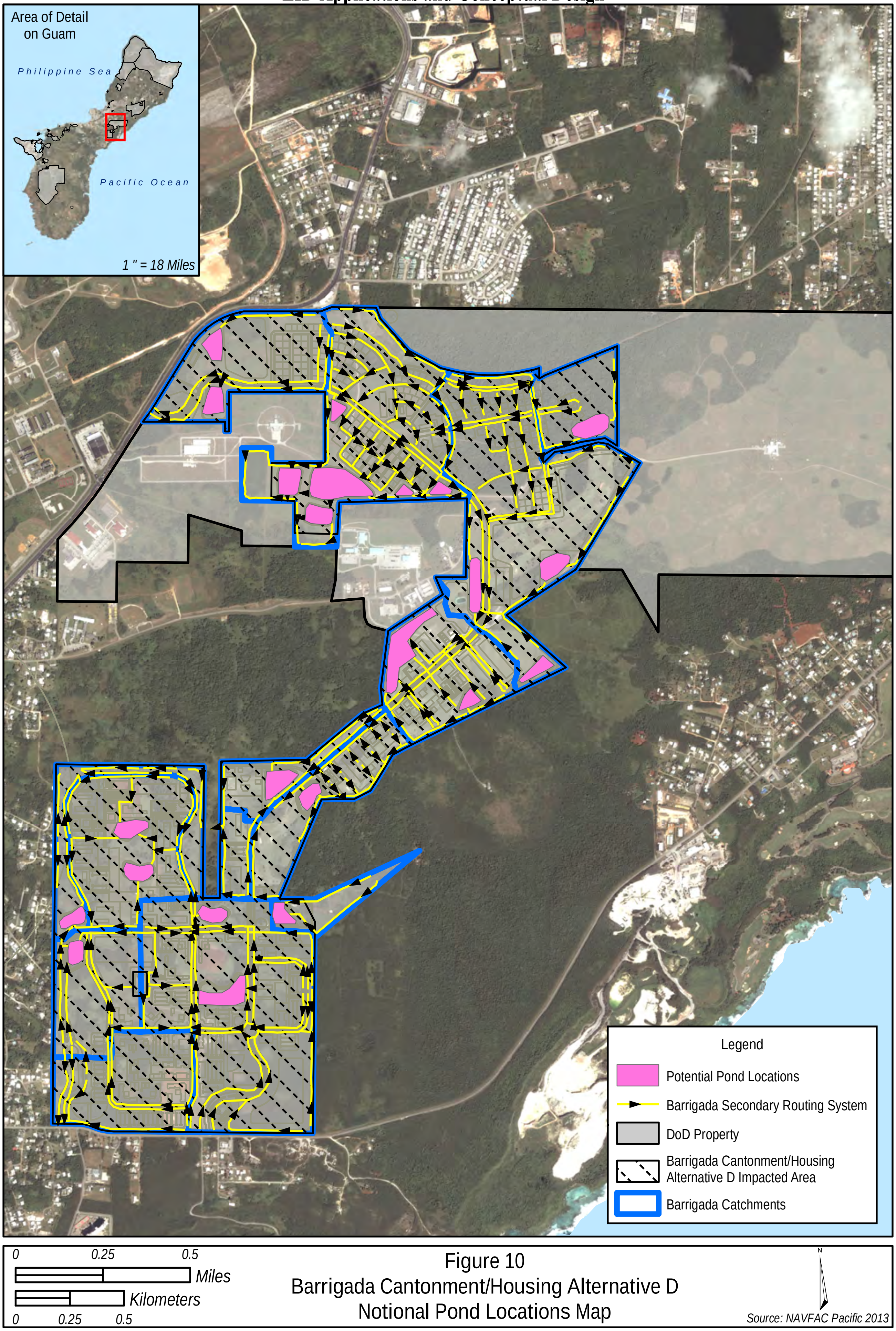


Figure 10
Barrigada Cantonment/Housing Alternative D
Notional Pond Locations Map

LFTRC Alternative Site Characteristics

Range Siting and Characteristics

Live-fire ranges must be carefully sited, constructed and maintained in order to be safe for range users and the community, as well as to be in compliance with applicable laws, rules, and regulations. Range siting must consider the physical characteristics of a location and required Best Management Practices (BMPs) to reduce the chance of off-site migration of munitions constituents. Range design and construction must focus not only on providing optimal training conditions, but also on ensuring that range users and neighbors are protected from physical hazards (e.g., employing berms, backstops, and surface danger zones). Finally, ranges must be operated and maintained so that off-site migration of munitions constituents does not occur (i.e., range clearance, lead harvesting, etc.). Guidance documents from both the USEPA and U.S. Army (Best Management Practices for Lead at Outdoor Shooting Ranges EPA 902-B01-001, Revised June 2005, Region 2; Training Ranges, Department of the Army, TC 25-8, 20 May 2010; Prevention of Lead Migration and Erosion from Small Arms Ranges, U.S. Army Environmental Center's Range XXI Team, U.S. Army Support Center, August 13, 1998), recommend considering the following criteria when siting a range to minimize and control un-intended off-site migration: soil characteristics, topography, annual precipitation (climatology), groundwater, surface water, vegetation. Information regarding site characteristics at the five proposed LFTRC sites are listed in Table 1 and details on these criteria are provided below:

- Soil characteristics are important because low soil hydraulic conductivity can slow water movement, and the correct soil pH will not hasten mobility of constituents.
- Sites with a flatter topography as opposed to sites with steeper slopes have reduced chances of off-site migration.
- Ranges should also be sited and constructed to avoid drainage to surface water bodies.
- Areas with lower annual precipitation rates are preferable to reduce potential off-site migration.
- A greater depth to groundwater and a lower estimated groundwater hydraulic conductivity indicate a reduced potential of off-site migration through groundwater.
- Vegetation cover (e.g., grasses, shrubs) also aids in reducing the potential for off-site migration.

The ranges would be in compliance with Range Management Plans and Range Environmental Vulnerability Assessments (MCO 3550.10) to reduced potential for release of hazardous materials and wastes and contamination of water and biological resources. Range management plans identify procedures for safe range usage and risk reduction. The vulnerability assessment identifies releases or substantial threats of a release of munitions constituents from range complex areas to off-range areas and is accomplished through a baseline assessment of operational range areas and, where applicable, the use of fate and transport modeling of the munitions constituents.

Potential Range Management BMPs for all ranges may include, but may not be limited to:

- Maintain grassy vegetation on berms
- Manage stormwater at ranges
- Restrict vehicular activities at ranges to designated/previously identified areas
- Conduct range clearance (remove expended rounds) of live-fire ranges with impact berms approximately every 5 years (depending on tabulated use)
- Adding soil amendments to maintain the soil pH between 6 and 8

LFTRC Alternative Site Characteristics

Table 1. LFTRC Alternative Site Characteristics

LFTRC Alternative	*Soil Type*[1]	*Estimated Hydraulic Conductivity (ft/day)*	*Depth to Groundwater (ft)*	*Annual Precipitation (in/year)*[5]	*Surface Water*[2]	*Wetlands*[6]	*Vegetation (% cover, type)*	*Topography*	*Extensive Grading Required*
Alternative 1 Route 15	Shallow, well drained limestone soils	1,050 to 1,540[3]	~400	90-95	None	None	100% trees, shrubs, and grass	Flat	No
Alternative 2 NAVMAG (East/West)	clay soils with high erosion potential	0.035[4]	N/A	105 to >115	Several (5) streams draining to Talofofo Bay are located within or down-gradient of ranges	Up to 17.7 acres of potentially jurisdictional wetland areas	100% shrubs and grass	Steep	Yes
Alternative 3 NAVMAG (North/South)	clay soils with high erosion potential	0.035[4]	N/A	105 to >115	Several (2) streams draining to Talofofo Bay are located within or down-gradient of ranges	Up to 36.9 acres of potentially jurisdictional wetland areas	100% trees, shrubs, and grass	Steep	Yes
Alternative 4 NAVMAG (L-Shaped)	clay soils with high erosion potential	0.035[4]	N/A	105 to >115	Several (7) streams draining to Talofofo Bay are located within or down-gradient of ranges	Up to 25.2 acres of potentially jurisdictional wetland areas	100% trees, shrubs, and grass	Steep	Yes
Alternative 5 Northwest Field	Shallow, well drained limestone soils	1,050[3]	~500	90-95	None	None	100% trees and shrubs	Flat	No
Andersen South (Hand Grenade Range-All Alternatives)	Shallow, well drained limestone soils	49,200[3]	~360	85-90	None	None	100% trees	Flat	No
Ideal site	Clay	Low	Deeper	Low	None	None	100% grass	Flat	No

*Notes: * Non-acidic*; AAFB = Andersen Air Force Base; ac = acre; ha = hectare

Sources:
[1] Young, F.L. 1988. Soil Survey of Territory of Guam. United States Department of Agriculture Soil Conservation Service. May.
[2] NAVFAC Pacific. 2013a. Watershed Reconnaissance Studies for the Potential Site of the Live Fire Training Range Complex, Guam. April.
[3] Rotzoll, K., S.B. Gingerich, J.W. Jenson, and A.I. El-Kadi. 2013. Estimating hydraulic properties from tidal attenuation in the Northern Guam Lens Aquifer, Territory of Guam, USA: Hydrogeology Journal, DOI: 10.1007/s10040-012-0949-9. 15 January.
[4] Mink, J.F. 1976. Groundwater Resources of Guam: Occurrence and Development: University of Guam Water Resources Research Center Technical Report 1.
[5] Gingerich, S.B. 2003. Hydrologic resources of Guam: U.S. Geological Survey Water-Resources Investigations Report 03–4126, 2 pl.
[6] NAVFAC Pacific. 2013b. Wetland Mapping – Report 1 Various Locations on Guam in Support of the Guam and Commonwealth of the Northern Marianas Military Relocation (2012 Roadmap Adjustments) Supplemental Environmental Impact Statement. January.

Watershed Reconnaissance Studies for the Potential Site of the Live Fire Training Range Complex, Guam

Prepared for

Joint Guam Program Office
Washington, D.C.

Prepared by

Naval Facilities Engineering Command, Pacific
258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Under:

Contract No.: N62470-10-D-3011, CTO KB18

April 2013

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Final Report

Watershed Reconnaissance Studies for the Potential Site of the Live Fire Training Range Complex, Guam

Prepared for

Joint Guam Program Office
Washington, DC

Prepared by

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258 Makalapa Drive, Suite 100
Pearl Harbor, HI 96860-3134

Under
Contract No.: N62470-10-D-3011, CTO KB18

April 2013

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This final report describes findings and observations from a literature and data review and a reconnaissance-level site assessment that was conducted in the Ugum and Talofofo Watersheds of Guam. The objective of this assessment was to characterize existing conditions related to drainage features, erosion susceptibility, flooding potential and biological resources that can potentially be impacted by placement of small arms and other weapons ranges in the proximity of the Naval Magazine Site (NMS) in south central Guam. The report also includes recommendations for best management practices (BMPs) and low-impact development (LID) measures that can be considered for implementation at the proposed ranges.

NOTE: The analyses presented in this report are based on LFTRC footprints, GIS Version 2.

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TABLE OF CONTENTS

ATTACHMENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
ac	acre(s)
BMP	Best Management Practice
CEC	Cation Exchange Capacity
CGP	Construction General Permit
CNMI	Commonwealth of the Northern Marianas Islands
CTW	Central Talofofo Watershed
DAWR	Division of Aquatic and Wildlife Resources
DNT	dinitrotoluene
DoA	Department of the Army
DoD	Department of Defense
DoN	Department of the Navy
EDR	Emergency Detonation Range
ESA	Endangered Species Act
EW	east-west
FEMA	Federal Emergency Management Agency
FRW	Fena Reservoir Watershed
FVR	Fena Valley Reservoir
GDA	Guam Department of Agriculture
GovGuam	Government of Guam
GSESCR	Guam Erosion and Sediment Control Regulations
HG	Hand Grenade
H&H	Hydraulic and Hydrologic
HSG	Hydrological Soil Group
ITRC	Interstate Technology Regulatory Council
KD	Known Distance
LFTRC	Live-Fire Training Range Complex
LID	low-impact development
LiDAR	Light Detection and Ranging
LULC	land use/land cover

MBTA	Migratory Bird Treaty Act
meq/100g	millequivalents per 100 grams of soil
mph	miles per hour
MPMG	multi-purpose machine gun
MRF	Modified Record of Fire
NAVFAC PAC	Naval Facilities Engineering Command Pacific
NMS	Naval Munitions Site
NRCS	Natural Resources Conservation Service
NS	north-south
NTW	Northern Talofofo Watershed
RCA	Range Condition Assessment
RDX	Research Department Explosive
RSEPA	Range Sustainability Environmental Program Assessment
SDZ	Surface Danger Zone
SEIS	Supplemental Environmental Impact Statement
SEPM	Soil Erosion Probability Model
STW	Southern Talofofo Watershed
SWCA	SWCA Environmental Consultants
TNT	trinitrotoluene
U.S.	United States
USDA	United States Department of Agriculture
USMC	United States Marine Corps
UXO	unexploded ordnance

EXECUTIVE SUMMARY

The Department of the Navy is considering locating a Live-Fire Training Range Complex for small arms weapons training by the United States Marine Corps in south-central Guam in the proximity of the Naval Munition Site. A reconnaissance study was conducted to characterize existing conditions related to drainage features, erosion susceptibility, flooding potential and biological resources that can potentially be impacted by placement of small arms and other weapons ranges in the proximity of the Naval Munitions Site in south-central Guam.

Data used in this study were obtained from the review of readily available literature and supplemented by observations made during a site reconnaissance visit. A desk-top analysis was conducted using the proposed range footprints (GIS Version 2). Major conclusions from this reconnaissance-level assessment are summarized below:

- None of the proposed range footprints for the three alignments actually fall within the Central Talofofo Watershed and therefore it is highly unlikely that stormwater runoff from any of the proposed footprint areas will drain to the Fena Valley Reservoir. The reservoir water quality should therefore not be impacted due to the construction and operation of the proposed Live-Fire Training Range Complex.
- For the proposed complex, adverse impacts may potentially be caused by siting, construction, and operations of the individual firing ranges.
- Siting-related impacts can be substantially reduced by refining/relocating the proposed range footprints.
- Implementation of site-specific BMPs at strategic locations should substantially ameliorate many of the projected potential adverse impacts associated with construction and operations of the proposed ranges.
- Incorporation of low impact design technology, which makes use of innovative methods to retain and manage stormwater onsite, in the final facility design will also help in eliminating or reducing potential adverse impacts associated with range operations.
- It is anticipated that developing the proposed footprint areas will not impact water surface elevation levels in FEMA-regulated floodplains; however detailed hydraulic and hydrologic modeling may have to be conducted to verify this assertion.
- During subsequent planning phases, focused biological surveys may have to be conducted to determine presence and distribution of threatened, endangered, and candidate species.

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1.0 INTRODUCTION

The Department of the Navy (DoN) is considering locating a Live-Fire Training Range Complex (LFTRC) for small arms weapons training by the United States Marine Corps (USMC) in south-central Guam in the proximity of the Naval Munition Site (NMS) (**Figure 1**). The proposed facility will potentially be used by individuals, crews, and small units for weapons training. The DoN is preparing a Supplemental Environmental Impact Statement (SEIS) for this training infrastructure project. Three alternative alignments for the proposed LFTRC at NMS are currently being evaluated in the SEIS; a north-south (NS) orientation, an east-west (EW) orientation and an L configuration (**Figure 2**). The SEIS is also evaluating for other LFTRC alternatives in northern Guam along with cantonment and family housing alternatives to support an USMC relocation to the island.

All three alignments at the NMS have the potential to be placed near rivers or streams in one of two watersheds, namely Talofofo or Ugum. Both watersheds eventually drain to the Pacific Ocean. The nearshore region off the Guam coastline, which receives drainage from these two coastal watersheds, is characterized by diverse and abundant coral growth. The Talofofo Watershed includes the Fena Valley Reservoir (FVR), which receives runoff from an approximately 5.8-square mile area. The FVR is an important domestic water supply for southern Guam.

Suspended sediments originating from range construction and operation, and munitions constituents such as lead originating from range operations, can potentially be picked up by stormwater runoff and transported to downstream areas where they may impact FVR water quality, biological resources in riparian areas, or nearshore coral reef communities. The United States (U.S.) military follows Department of Defense (DoD) Directive 4715.11 "*Environmental and Explosives Safety Management on Operational Ranges within the United States*" to ensure long-term viability of the operational range while protecting human health and the environment. Since operational ranges may have varying amounts of munitions constituents present, consideration of hydrologic and hydro-geologic data as part of range design and siting is important, so that transport mechanisms are identified in advance and risks of downstream migration are minimized.

1.1 Study Purpose

The purpose of the LFTRC Watershed Reconnaissance Study (Study) was to gather and evaluate data for the following:

- Characterize existing conditions in the riparian areas and surface water features (stream channels, wetlands, and open water) within the LFTRC study area (**Figure 3**). The characterization also included identification of degraded locations within the study area.
- Identify key locations within the study area that (a) contribute significant amounts of runoff and (b) are prone to erosion and/or flooding.
- Identify best management practices (BMP) and low-impact development (LID) measures that can be strategically applied at selected locations within the study area to control soil erosion and sediment runoff and reduce the potential for downstream flooding.

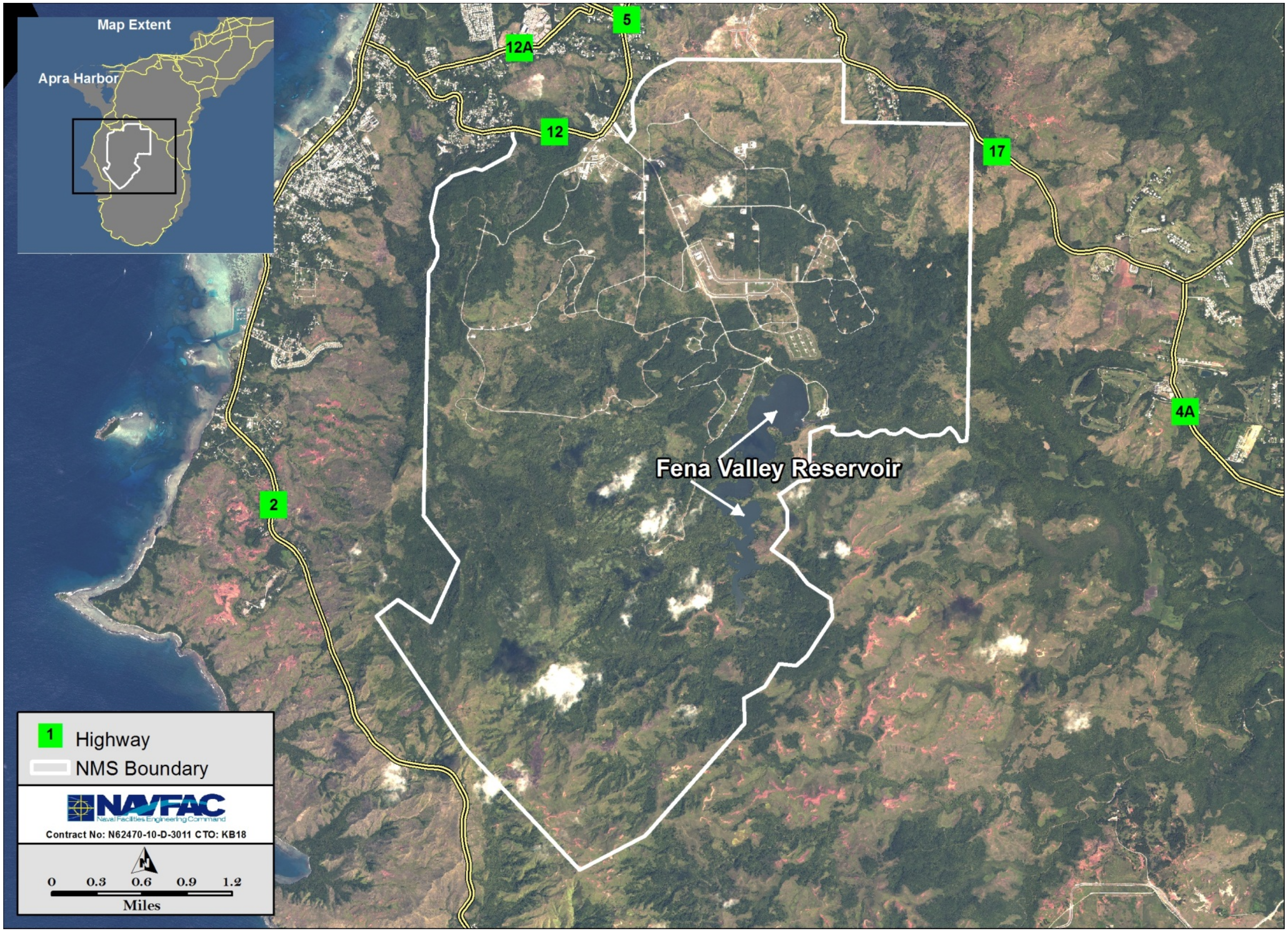

Figure 1: Location of Naval Magazine Site, Guam

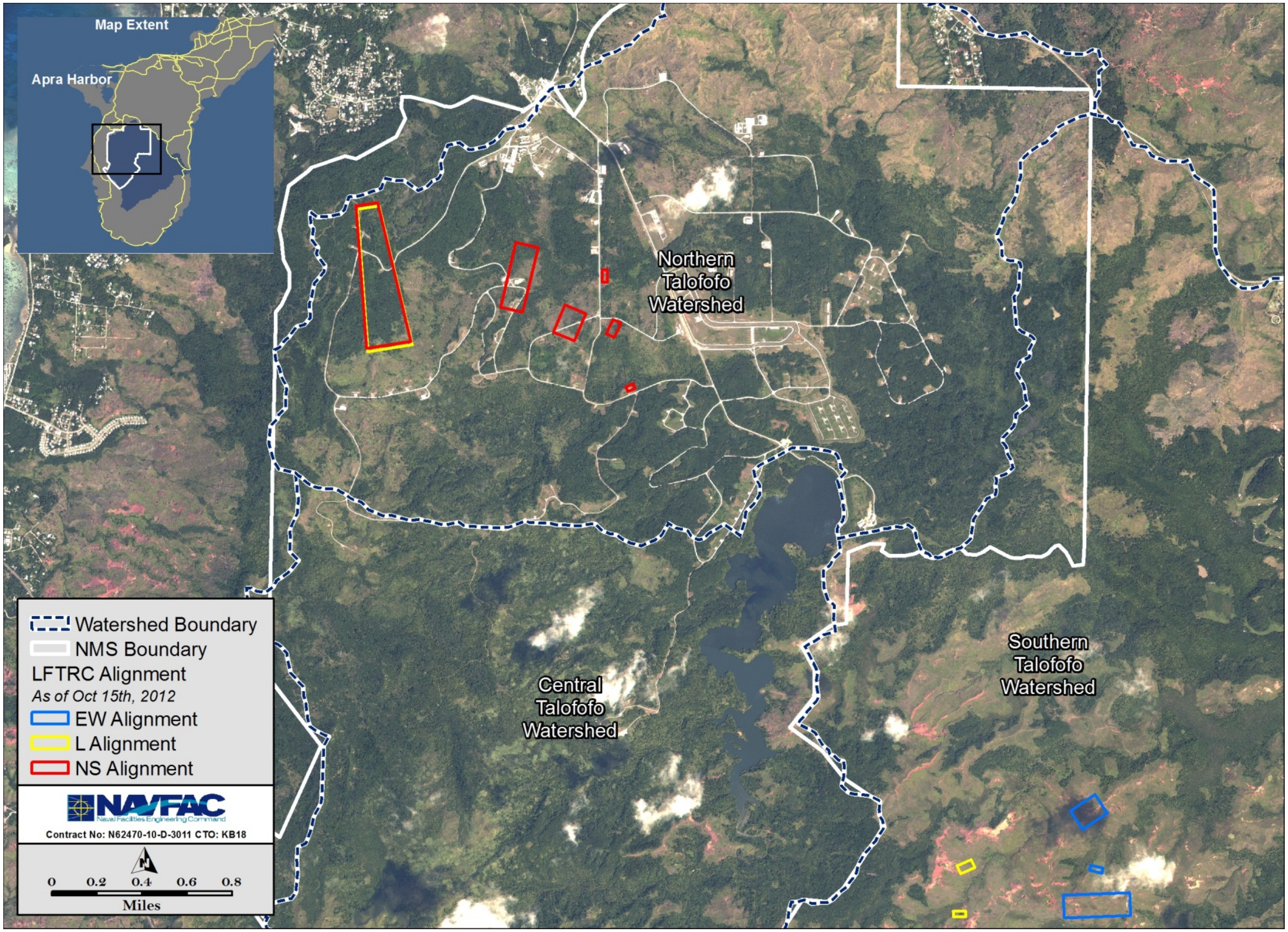

Figure 2: LFTRC Alternative Alignments (GIS Version 2)

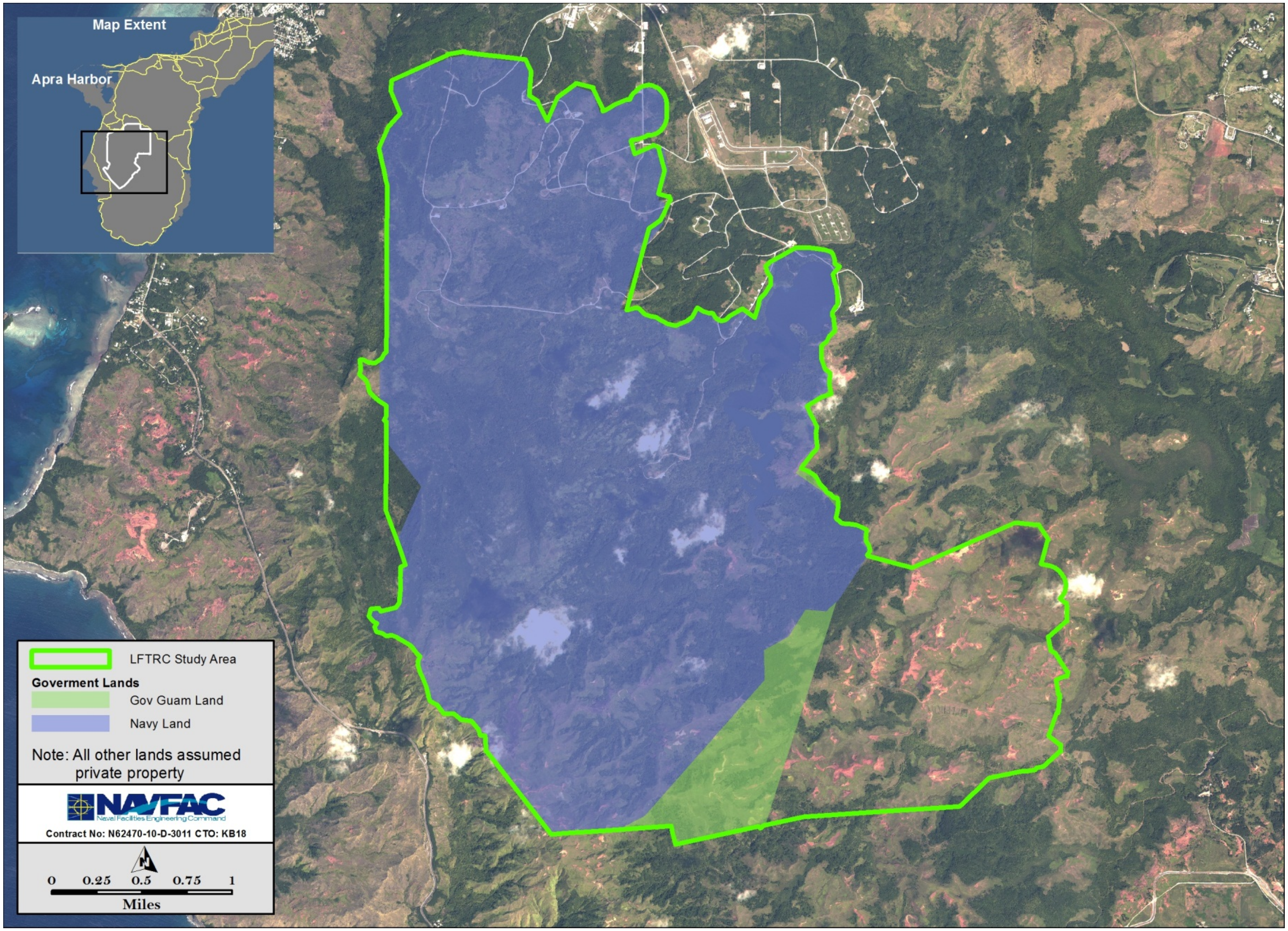

Figure 3: LFTRC Watershed Reconnaissance Study Area

- The data for characterization of existing conditions and assessment of erosion and flooding potential were obtained from review of readily available literature supplemented by observations made during a reconnaissance site visit. Marine natural resources in the nearshore coastal areas were not observed or evaluated because the shoreline itself is significantly outside the proposed project footprint.

1.2 Report Organization

- This report is organized as follows:
- The study purpose and study area were previously described in Section 1. This section also includes an overview of the proposed LFTRC alignments.
- Findings from a literature and data review and observations made during a reconnaissance site visit are presented in Section 2.
- Existing conditions within the LFTRC study area are described in Section 3.
- Recommendations for BMPs and LID practices that can be considered for implementation at the proposed firing ranges to reduce soil erosion, manage sediment and munitions-constituent mobilization in the stormwater runoff, and reduce offsite flooding potential are discussed in Section 4.
- Section 5 contains key observations and a discussion of the findings and recommendations.

1.3 Study Area

The study area, which included the drainage basins associated with rivers and streams located in the vicinity of the proposed alignments, is located in south-central Guam. It includes the lower half of the approximately 8,500-acre (ac) NMS and the entire drainage basin of the FVR (**Figure 3**). The munitions magazines are mostly confined to the northern portions of the NMS, while the southern part is largely undeveloped. The FVR is the largest freshwater body on the island; it was constructed by the Navy in 1951 to provide a dependable source of potable water. This reservoir currently provides storage for the Navy potable-water system and delivers approximately 4 million gallons of freshwater per day for municipal usage.

Land cover in the approximately 7,650-ac study area is dominated by forested and savanna grasslands (**Table 1**). Best available land ownership data for the study area are summarized in **Table 2** and illustrated in **Figure 3**.

Table 1: Study Area Land Use/Land Cover Data

Land Use/Land Cover	Ac
Barren/Badlands	201
Forested	3,635
Savanna	2,796
Developed	129
Wetlands	696
Open Water	193
Total	**7,650**

Table 2: Study Area Best Available Land Ownership Data

Property Owner	Total (ac)
Navy	5,015
Government of Guam (GovGuam)	715
Private	1,920
Total	**7,650**

The southern half of Guam, where the study area is located, is dominated by volcanic and volcanically derived rock (Umatac Formation) covered by deep clay soils (Natural Resources Conservation Service [NRCS] 2001). This type of soil does not readily allow water infiltration, but rather drains mainly by way of surface streams and rivers. This part of the island including the study area is therefore characterized by significant number of surface water features.

The annual average rainfall on the island exceeds 80 inches. Severe weather systems such as typhoons can dump unusually large amounts of precipitation in a very short time. In 2002 during Typhoon Chata'an for example, the Almagosa rain gauge west of FVR recorded a maximum of 6.48 inches within a 1-hour period. Surface water gages indicated near 100-year flow events in some locations. Landslides and extensive erosion occurred as a result of the heavy rains. The suspended sediment concentration in the FVR became so high that the water treatment facility could no longer operate (**Figure 4**) (Fontaine 2003). The FVR produced no water for days until modifications were made to the intakes to skim water off the reservoir's surface (Edward Lynch, HDR EOC, pers. comm., 2012).

Figure 4: FVR Following Typhoon Chata'an

1.4 Proposed LFTRC Overview

Six different types of firing ranges are associated with each of the three LFTRC alignments being evaluated in the SEIS that are located within or immediately adjacent to the NMS—Known-Distance (KD) Rifle, Hand Grenade (HG), Pistol, Non-standard Small Arms (Small Arms), Modified Record of Fire (MRF), and Multi-Purpose Machine Gun (MPMG). Footprints proposed for individual ranges associated with each of the three alignments are shown in **Figures 5**, **6**, and **7**[1].

Each proposed range footprint includes an active operational area and a surface danger zone (SDZ). The SDZ is delineated based on a mathematically predicted area in which a projectile will impact upon return to earth, either by direct fire or ricochet. It represents the area within which all projectile fragments associated with firing activities at the proposed range will be contained. The SDZs are generally designed to make the probability of hazardous fragment escapement from installation boundaries unlikely and minimize the danger to the public, installation personnel, facilities/equipment, or property (Department of Army 2012).

An SDZ usually consists of four areas—the target area, dispersion area, ricochet area, and a safety buffer. The dispersion area, which typically covers the surface between the target line and the ricochet area, is a more realistic measure of the area within which potential environmental impacts may occur.

[1]These footprints are based on GIS Version 2.

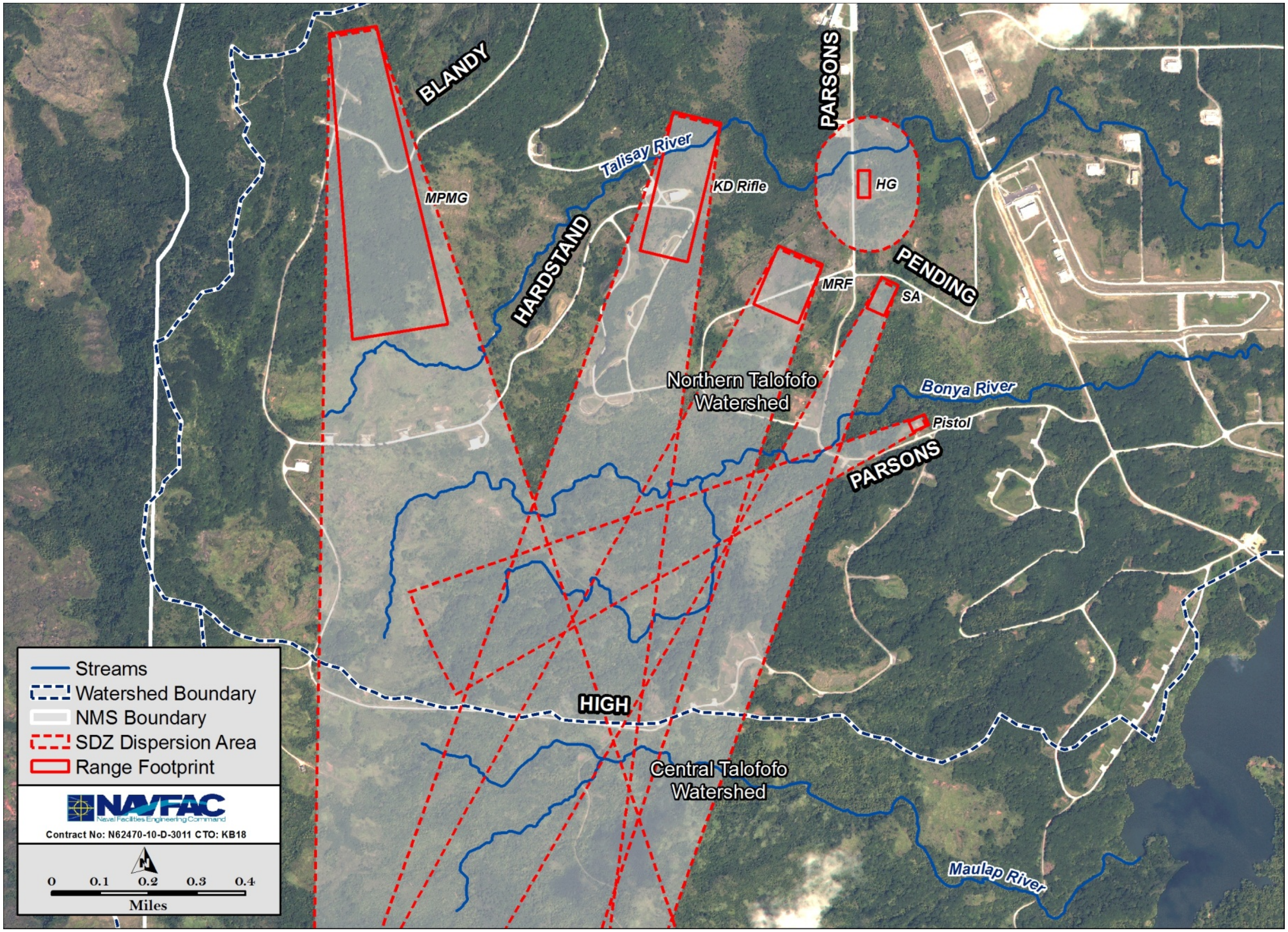

Figure 5: LFTRC North-South Alignment – Proposed Range Footprints

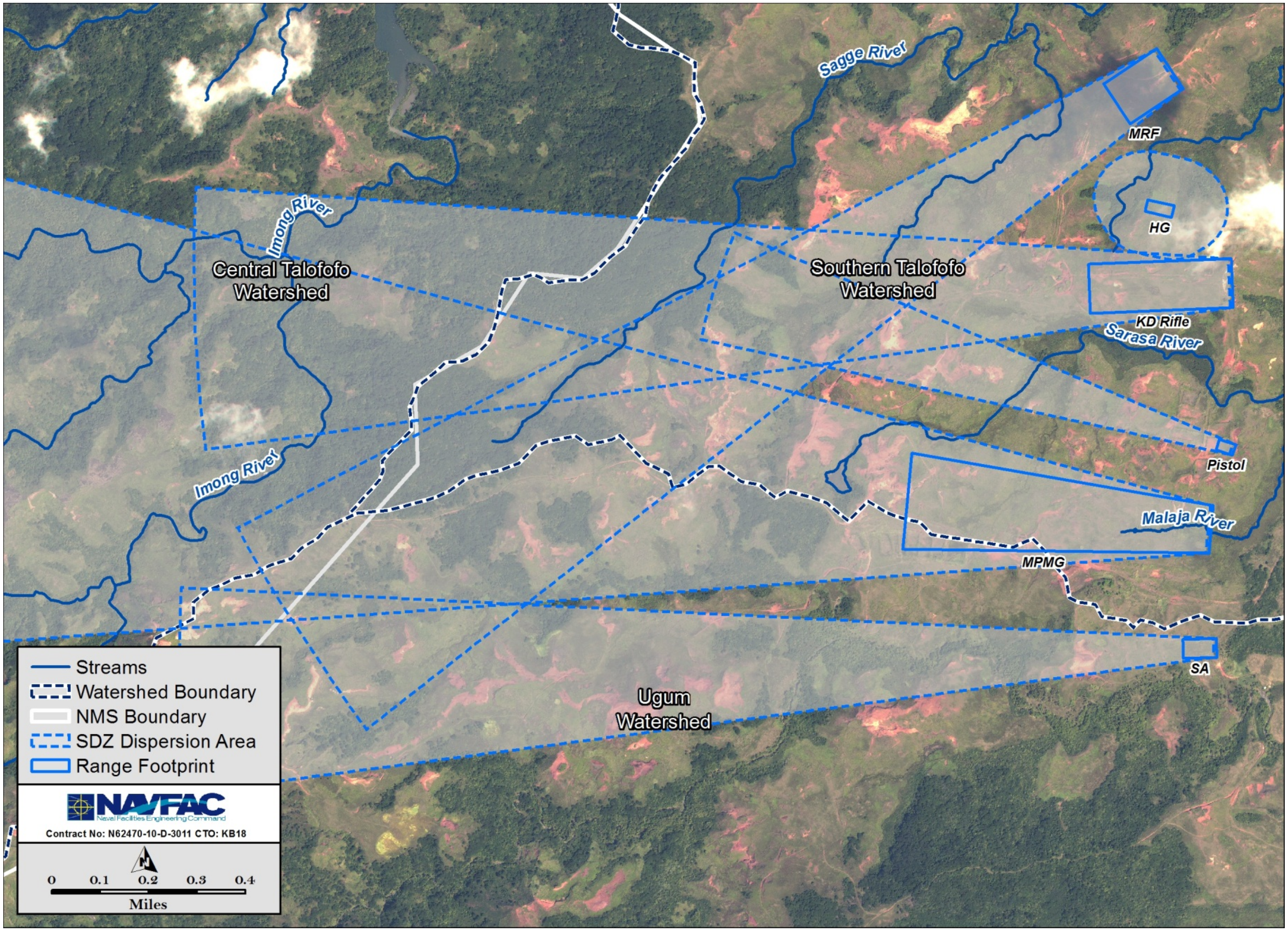

Figure 6: LFTRC East-West Alignment – Proposed Range Footprints

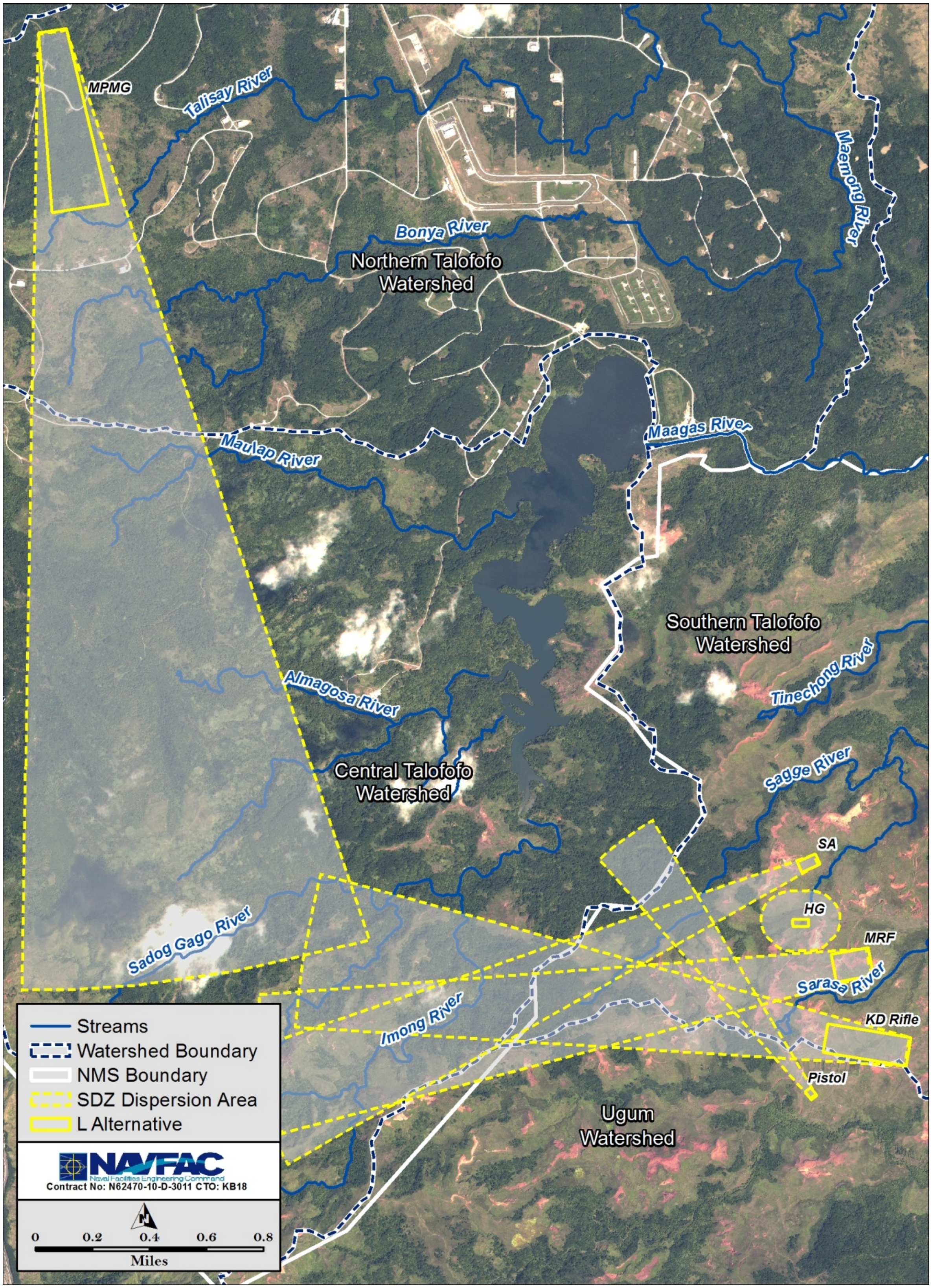

Figure 7: LFTRC L-Alignment – Proposed Range Footprints

All three alignments predominantly lie within the Talofofo Watershed. **None of the proposed range footprints fall within the boundaries of the Central Talofofo Watershed (CTW)**. The areas proposed for locating the six NS-Alignment Ranges are situated in the northern portion of the Talofofo Watershed. All six ranges face towards the south.

Four of the six proposed EW-Alignment Range footprints are located in the southern portion of the Talofofo watershed. The proposed EW-Alignment Small Arms Range footprint and a portion of this alignment's MPMG Range footprint extend into the Ugum Watershed. The EW ranges predominantly face west, and all proposed footprints are located on privately-owned lands.

Three of the six proposed firing ranges associated with the L-Alignment lie completely in the southern part of the Talofofo Watershed. The proposed KD Rifle Range footprint extends from the southern Talofofo into the Ugum Watershed. The proposed Pistol Range footprint is fully located within the Ugum Watershed. The L-Alignment MPMG Range has the same proposed footprint and location as the NS-Alignment MPMG Range, which is located in the northern portion of the Talofofo Watershed.

2.0 DATA COMPILATION

Data used in this assessment were obtained from the review of readily available literature and supplemented by observations made during a site reconnaissance visit.

2.1 Literature Review

Range Condition Assessment, Marianas Land-Based Operational Range Complex Decision Point 1 Recommendation Report, Guam and Commonwealth of the Northern Mariana Islands (NAVFAC PAC 2008)

This report presents findings from a Range Condition Assessment (RCA) that was completed for the Farallon de Medinilla Range, Commonwealth of the Northern Mariana Islands (CNMI) and the Emergency Detonation Range (EDR) within NMS, Guam. The RCA was part of the Navy's Range Sustainability Environmental Program Assessment (RSEPA). The EDR facility is used to dispose of World War II-era unexploded ordnance (UXO) discovered on Guam and other islands of the Marianas, as well as for training purposes. This range is located approximately 2,400 feet upstream of the FVR in the Almagosa drainage basin.

The CalTOX model was used to predict munitions contaminant loadings at the downstream terminus of the Almagosa River at FVR. CalTOX was developed by the California Department of Toxic Substances Control and consists of a multimedia transport and transformation model and exposure scenario models for conducting risk assessments. The model allows the prediction of mass chemical transport through air, groundwater, and surface water due to introduced contaminants over periods of time.

The model predicted various explosives compounds (TNT, Research Department Explosive, and 2, 4-Dinitrotoluene [DNT]) to be found at detectable levels, however these levels did not represent a health concern. No concentrations of explosive compounds were detected at the discharge point to the FVR.

Army Small Arms Training Range Environmental Best Management Practices (BMPs) Manual (United States Army Environmental Center 2005)

This manual was developed as a reference guide for maintaining the long-term sustainability of operational small arms ranges and areas, primarily centered on the potential for transport of metallic munitions constituents and erosion concerns. It includes procedures for range evaluation based on local hydrology, soils, and range use. BMPs are described in detail, ranging from engineered solutions to recommended operational practices, all of which seek to prevent erosion and limit transport of metallic munitions constituents (primarily lead).

Environmental Management at Operating Outdoor Small Arms Firing Ranges (Interstate Technology Regulatory Council [ITRC] 2005)

This technical guide was developed by the ITRC, which includes representatives from Federal and state environmental regulatory agencies, Indian tribes, and stakeholders from industry, academia, and the public. The guidelines are intended to assist in the development, application, and monitoring of environmental management plans at active small arms ranges. This document also presents information on the fate and transport of the main munitions constituent of concern, which is primarily lead. It provides guidance on the selection and implementation of BMPs appropriate to the range conditions.

Department of the Army (DoA) Pamphlet (DA PAM) 385-63 Range Safety (DoA 2003)

This pamphlet is to be used in conjunction with Army Regulation 385-63/Marine Corps Order 3570.1C. It contains standards, procedures, and criteria for range safety topics. Information on SDZs is provided for a wide range of military munitions. Guidelines for installation and unit safety programs are provided and range access and control procedures are defined.

Fena Watershed Resource Assessment: Erosion and Sediment Identification for Critical Area Treatment (NRCS 2001)

The purpose of this study was to assess natural resources within the FRW in order to better understand the potential for protecting and enhancing water quality and quantity within the Imong, Almagosa, and Maulap rivers; their tributaries; and the Fena Reservoir. The assessment identified, located, and quantified potential sediment sources, and linked the sources to general and critical areas that needed to be treated or managed.

This study delineated seven sub-watersheds within the FRW and evaluated sediment contribution from each sub-watershed. Primary sources of sediment were identified as savannas, ravine forests, badlands, stream banks and streambeds, and road banks and roadbeds. Accelerated sheet and rill erosion was identified as the main type of erosion. Mass wasting (slips, slumps, etc.), gully erosion, and channel erosion were also recognized as significant contributors. Average sediment yield to the Fena Reservoir from all sources totaled approximately 25,800 tons/year.

Analysis of sediment delivery mechanisms indicated that sheet and rill erosion contributed nearly 93 percent of the erosion and sediment occurring in the FRW. Accelerated sheet and rill erosion was tied to causes such as fire, over-browsing (by managed livestock or animals), and other human disturbances. Badland areas had the highest estimated erosion rate (240 tons/acre/year) of the eight land units delineated. The steeply sloped savanna on the volcanic (Akina) soils had the next highest rate (63 tons/acre/year).

The Almagosa Sink sub-watershed, wetland(s), and the limestone areas generally act as natural sediment basins and are relatively stable. The limestone areas have low background erosion rates. Rate of erosion from roads and road banks is relatively low when compared to sheet and rill erosion rates.

Guam and Tinian Wetland Inventory (AECOS 2009)

This document contains an inventory of wetlands located on Navy-owned lands in Guam and Tinian. Wetlands present within the NMS boundary are described in detail. This description includes information on geology, soils, vegetation, and wetland characteristics associated with known, newly recorded, and previously misidentified wetlands. The wetland identification numbering system used in this report follows previous efforts by Duenas and Associates (1998, 1999a, 1999b). For consistency, this report also uses the same identification numbering system to identify wetlands that occur in and around areas proposed for locating individual ranges.

2.1.1 Soil Erosion Probability Model

Data compiled during the literature review on relevant watershed characteristics such as soil types, topography, land use, land cover (vegetation), and distance to prominent water bodies were used to create a GIS-based soil erosion probability model (SEPM). SEPM input data sources are identified in **Table 3**.

For each area within the watershed, the SEPM assigns a *qualitative* probability (low score = 0 to high score = 9) of the area's susceptibility to soil erosion. SEPM output is shown in **Figure 8**. Model output was used to identify areas that were characterized by relatively high susceptibility to soil erosion (Score ≥ 5). Areas with a SEPM score of ≥ 5 that were located on Navy- and GovGuam-owned lands were selectively targeted for ground inspections during the site reconnaissance visit.

Table 3: SEPM Input Data Sources

Data Field	Data Source
Soil	Natural Resources Conservation Service (NRCS) Soil Survey Geographic database (NRCS 2009).
Vegetation and Land Cover	US Forest Service Vegetation Classification Scheme for Guam USDA Forest Service Region 5 State and Private Forestry, Forest Health Protection (2006)
Topography	United States Geologic Service National Elevation Dataset (NED) (2009).

2.2 Site Reconnaissance Visit

A site visit was conducted from 22 February to 27 February 2012, during which accessible Navy- and GovGuam-owned lands within the overall LFTRC study area were assessed[2]. Areas with relatively high erosion susceptibility, as indicted by the SEPM, were selectively targeted for reconnaissance-level observations. Even though February is generally a dry month in Guam, it did rain several times during the site visit, which allowed the field investigators to observe in real time stream flows at several locations.

The purposes of the site visit were to (1) validate literature and data review findings and (2) observe and document existing conditions for key relevant parameters such as hydrology (surface water bodies), drainage (defined and undefined channels and flow-ways), topography (elevations), and biology (habitats and associated fauna and flora, with special emphasis on threatened and endangered species habitats). Degraded areas (i.e. areas with a high level of existing erosion) and sites with high erosion susceptibility were flagged. Selected photographs from the site visit are shown in **Attachment A**.

[2]At the time of site visit, an earlier iteration of the proposed LFTRC range footprints (Version 1) was being discussed. These footprints were subsequently refined in October 2012 (Version 2). However, observations made during the February 2012 site visit are still relevant because the revised footprints are also located within the same general area as the originally proposed range footprints.

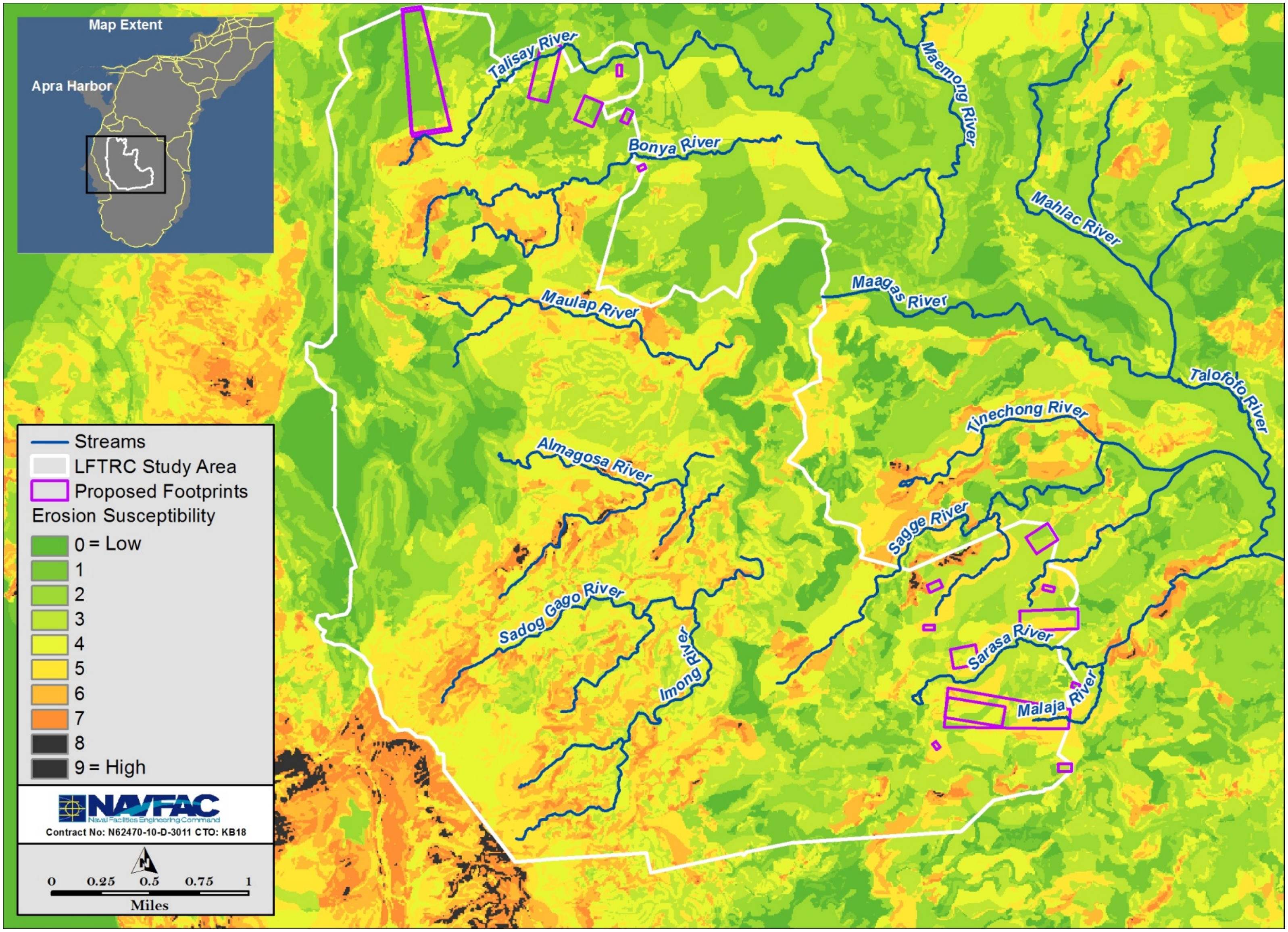

Figure 8: Soil Erosion Probability Model Output for the LFTRC Study Area

2.3 Data Gaps

Accessible portions of the study area were assessed at a reconnaissance level only. Detailed site-specific assessments including baseline biological and topographic surveys will have to be conducted to generate additional data to support subsequent planning phases. At a minimum, the following types of additional data are likely to be needed to further define and configure recommendations from this reconnaissance assessment:

- Topography – The available United States Geological Survey topographic maps have 20-foot contour intervals. Typically, a contour interval of 1 foot is needed for developing detailed design of engineered BMPs and/or erosion and sediment runoff control features. Obtaining accurate ground elevations under forest canopy is difficult with conventional aerial photogrammetry. Optical remote sensing LiDAR (Light Detection and Ranging) techniques may provide the required resolution.
- Footprint Boundaries – The proposed range footprint boundaries appear to account only for the area between the firing points and target line and small additional areas at both ends of the range. This needs to be confirmed and if correct, the footprint area will have to be expanded to accommodate range support functions including parking lots, staging areas, range buildings, range access roads, or areas beyond the target line for target manipulation.
- Biological Surveys – Many of the proposed range footprint areas appear to include natural areas that may potentially be used by federally and Guam-listed threatened and endangered species (see Section 3 for detailed discussion). For the preferred alignment range footprints, detailed baseline biological surveys will have to be conducted to characterize the quantity and quality of such habitat and its current usage by threatened and endangered species.
- Regulatory and permitting requirements.

3.0 EXISTING CONDITIONS CHARACTERIZATION

Existing conditions in the study area were characterized based on the findings of the literature and data review supplemented by observations made during the reconnaissance site visit.

3.1 Physical Landscape Overview

3.1.1 Climate/Weather

The climate of Guam is characterized as tropical marine with a mean high temperature of 81 degrees Fahrenheit (°F) (27 degrees Celsius [°C]) and mean low temperature of 76°F (24°C). The climate is hot and humid with little seasonal variation in temperature. Relative humidity during the day ranges between 65 and 80 percent and typically increases at night to between 85 and 100 percent.

Persistent easterly flows dominate the island’s air circulation patterns during the drier months. These trade winds are typically out of the east at less than 10 miles per hour (mph), but are usually lighter and more variable during the summer doldrums period. Storms are common in the summer and fall.

3.1.2 Rainfall

Lander Guard (2003) analyzed rainfall data and patterns over Guam for a 50-year period and reported that the rainfall gradients and patterns on Guam are strongly influenced by the northeast-southwest orientation, shape, and terrain of the island. Their analysis indicated that annual rainfall over the open ocean, unperturbed by the island, ranges between 80 and 110 inches. Two distinct seasonal variations in precipitation occur, a wet season typically extending from July through November and a dry season extending from January through May; December and June are transitional months.

The analysis further showed that there are several rainfall maxima and minima on the island. The maxima are in the north-central part of Guam, down the western mountains, across the southern mountains, and up the southeastern coastline. The minima are located southwest of Mount Santa Rosa to Tiyan, south of Ritidian Point, Orote Point to Cabras Island, south-central Guam east of the FVR and northeast toward Barrigada, and southwestern Guam and Cocos Island. The strongest rainfall gradients are located along and parallel to the major mountain ranges. Strong gradients are also seen where terrain produces a rain shadow. Mount Santa Rosa and Mount Barrigada produce strong rain shadows, primarily during northeasterly and easterly flow during the drier months.

3.1.3 Geology and Topography

Guam is the largest and southernmost island in the Mariana Islands archipelago. The islands are volcanic, resulting from subduction of the Pacific tectonic plate beneath the Philippine plate at the Mariana Trench, located south and east of Guam. The Island of Guam was formed by two separate emergent volcanoes that fused and formed one island.

The central and northern sections of the island consist of a limestone plateau that reaches 600 feet (183 meters) above sea level, with steep cliffs dropping down to a narrow coastal shelf. Within the NMS, which includes the study area, volcanic hills rise to a maximum height of 1,334 feet (407 meters) above sea level (Tracey et al. 1964).

Six geologic formations, which date back as far as the Eocene Epoch of the late Tertiary Period, are associated with the study area (**Table 4**).

Table 4: Geologic Formations Associated with the LFTRC Study Area

Geologic Formation	Epoch	Formation Description
Alifan limestone	Miocene and Pliocene	Massive coarse-to-fine grained recrystallized limestone; generally pale pink, buff, or white but locally red, yellow, or brown. Characterized by dominance of stick-like *Porites* and *Acropora* and by long calcite tubes formed by burrowing worms or gastropods. Locally argillaceous above base. Maximum estimated thickness of Alifan limestone is 150 feet (46 meters).
Talisay member	Oligocene	Yellow, green, and red clay and lenticular clayey conglomerate and lignite; gray to green marl containing sticklike *Porites* and *Acropora*, and interbedded limestone lenses, 2 to 30 feet (1 to 9 meters) thick. Generally unconformable with the volcanic; locally overlies the Bonya limestone.
Alutom formation	Eocene and Oligocene	Bedded breccias, conglomerates, sandstones, turbidites, sandy limestones, and micritic to bloclastic limestones. Clasts in the breccias and conglomerates generally are two-pyroxene andesites, although rare olivine phyric basalts and hornblende andesite clasts are also present. Estimated thickness of the Alutom formation ranges from 1,850 to 2,000 feet (564 to 610 meters).
Bolanos pyroclastic member	Miocene	Breccias, conglomerates, and sandstones consisting largely of fragmented andesite. These andesites typically have prominent euhedral augite phenocrysts up to 1 centimeter in length and millimeter-scale plagioclase phenocrysts. Limestone clasts are conspicuous in some breccias and conglomerates. Estimated thickness of Bolanos pryoclastic member ranges from 750 to 1,000 feet (229 to 305 meters).
Dandam flow member	Miocene	Compact medium-to-coarse-grained porphyritic andesite flows separated from the underlying Bolanos pyroclastic member by a flow of breccias approximately 10 feet (3 meters) thick. Maximum thickness of member 50 feet (15 meters).
Alluvium	Quaternary	Alluvial clay deposits, mostly 30-100 feet (9 to 30 meters) thick, muck and clay in marshy estuarine deposits on the west coast, scattered sand and gravel bars within deposits near southeast river mouths, and clay fill in large sinks and limestone areas.

Source: Siegrist et al. 2007.

3.1.4 Soils

The U.S. Department of Agriculture (USDA) has identified 17 soil series on Guam (Young 1988). Seven of these soil types are likely to occur within the study area (**Table 5**).

Soils are classified into hydrologic soil groups (HSG's), which indicates the minimum rate of infiltration obtained for bare soil after prolonged wetting (USDA 1986). The infiltration rate is the rate at which water enters the soil at the soil surface. It is controlled by surface conditions. The HSG also indicates the transmission rate—the rate at which the water moves within the soil. This rate is controlled by the soil profile.

Table 5: Soils Series Associated with the LFTRC Study Area

Soil Series	Soil Type/Phase	Hydrological Soil Group*
Agfayan Series	Agfayan Clay, 15 to 30 % Slopes	Type D
	Agfayan-Rock Outcrop Complex, 30 to 60 % Slope	
Akina Series	Akina Silty Clay, 15 to 30 % Slopes	Type B
	Akina Silty Clay, 7 to 15 % Slopes	
	Akina-Agfayan Association, Steep	
	Akina-Atate Association, Steep	
	Akina-Atate Silty Clays, 15 to 30 % Slopes	
	Akina-Atate Silty Clays, 30 to 60 % Slopes	
	Akina-Atate Silty Clays, 7 to 15 % Slopes	
	Akina-Badland Association, Steep	
	Akina-Badland Complex 30 to 60 % Slopes	
	Akina-Badland Complex, 15 to 30 % Slopes	
	Akina-Badland Complex, 7 to 15 % Slopes	
	Akina-Urban Land Complex, 0 to 7 % Slope	
Inarajan Series	Inarajan Clay, 0 to 4 % Slope	Type C
Pulantat Series	Pulantat-Chacha Clays, Undulating	Type C
	Pulantat-Urban Land Complex, 0 to 7 % Slope	
	Pulantat-Urban Land Complex, 7 to 15 % Slope	
Ritidian Series	Ritidian Rock Outcrop Complex, 16 to 60 % Slopes	Type D
	Ritidian Rock Outcrop Complex, 3 to 15 % Slopes	
Togcha Series	Togcha-Akina Silty Clays, 3 to 7 % Slopes	Type B
	Togcha-Akina Silty Clays, 7 to 15 % Slopes	
	Togcha-Ylig Complex, 7 to 15 % slopes	
	Togcha-Ylig Complex, 3 to 7 % Slopes	
Ylig Series	Ylig Clay, 0 to 3 % Slopes	Type C
	Ylig Clay, 3 to 7 % Slopes	

HSG Key:

Type A – Low runoff potential and high infiltration capacities. Soil texture is sand, loamy sand, or sandy loam.
Type B – Moderate infiltration capacities with low to moderate runoff potentials. Soil texture is silt loam or loam.
Type C – Low infiltration rates and moderate to high runoff potential. Soil texture is sandy clay loam.
Type D – Very low infiltration capacity and very high runoff capacities. Soil Texture is clay loam, silty clay loam, sandy clay, silty clay, or clay.

The following descriptions of the seven soil types that are likely to occur within the study area are based on Young (1988).

- **Agfayan Series**. Primarily associated with volcanic uplands, this series consist of well-drained, moderately slowly permeable soils formed in residuum derived from tuff, tuff breccias, and tuffaceous sandstone deposited in a marine environment. Clay content ranges from 60 to 80 percent. This soil type is not well-suited to commercial or subsistence farming and is of limited application to grazing due to steep slopes and a limited depth of bedrock (10 to 38 centimeters). Protecting this soil series from wildfire by planting suitable native trees can enhance this soil series' value as watershed and wildlife habitat.
- **Akina Series**. Primarily associated with volcanic uplands, this series consists of well-drained, moderately slowly permeable soils formed in residuum derived from tuff and tuff breccias. The top soil horizon consists of silty clay or clay, and total clay content of the soil ranges from 60 to 80 percent. Akina soils are moderately suited to commercial and subsistence farming, but more suited to grazing. Primary limitations of this soil type are potentially severe erosion hazard, low soil fertility, soil acidity, and lack of water during the dry season.
- **Inarajan Series**. This series is typically found in valley bottoms and coastal plains and consists of deep to very deep, somewhat poorly drained, slow permeable soils. These soils are formed in alluvial material deposited by streams in a riverbed, flood plain, or delta. The top soil horizon is typically clay or silty clay, but can also be sandy clay loam in places. Total clay content of the soil is 45 to 80 percent. This soil is moderately suited for commercial and subsistence farming and grazing but is limited by excessive water during the rainy season, and a lack of water during the dry season. The series is generally characterized by a slight hazard of erosion. It is most suited as watershed or wildlife habitat and can be enhanced by protecting the vegetative cover from disturbance and protecting seasonal pools from pollutants (including sediment).
- **Pulantat Series**. These are shallow, well-drained, slowly permeable soils found over limestone, generally on upland plateaus and hills. They are formed in residuum derived from argillaceous coralline limestone and have a top horizon of silty clay or clay. Total clay content of Pulantat soils is 70 to 90 percent. These soils are moderately suitable for commercial and subsistence farming and grazing and can be used as watershed or wildlife habitat. Pulantat soils are limited by their shallow depth, very low available water capacity, and moderate to severe erosion hazard and susceptibility to compaction.
- **Ritidian Series**. This series consist of very shallow, well-drained, moderately rapidly permeable soils found on plateaus and escarpments. They are formed in slope alluvium, loess, and residuum derived from sediment overlying coralline limestone. The top soil horizon is clay loam or clay with a clay content ranging from 35 to 60 percent. This soil series is not suited for farming or grazing but can be used as watershed and wildlife habitat. The main limitations of this soil are steepness of slope and jagged, uneven limestone rock. Ritidian soils are characterized by slight risk of erosion.
- **Togcha Series**. The Togcha Series soils are very deep, well-drained, moderately permeable soils found on volcanic uplands. Togcha soils are formed in slope alluvium

derived from weathered tuff and tuff breccias. Soil clay content ranges from 55 to 60 percent, and the top soil horizon consists of silty clay loam or silty clay. Togcha soils are well suited to commercial and subsistence farming and grazing. Limitations of this soil include erosion hazard, low soil strength, soil acidity, and lack of water during the dry season.

- **Ylig Series**. These types of soils are found on steep exposures, concave hillsides, and drainages and are very deep, poorly drained, and moderately slowly permeable. This soil is formed in alluvium derived from weathered tuff and tuff breccias. Ylig soils form hummocks in some areas. Total soil clay composition ranges from 50 to 70 percent, and the top soil horizon consists of silty clay or clay. It is moderately suited to subsistence farming and grazing, but poorly suited to commercial farming. Limitations of this soil include areas of poor drainage, soil acidity, moderate erosion hazard, and lack of water during the dry season. Ylig soils have use as watershed and wildlife habitat and can be enhanced by preserving the existing vegetation.

3.1.5 Land Use/Land Cover (LULC)

The study area is characterized by five vegetation, two urban, and two barren LULC types. The following descriptions of these nine LULC types are based on Liu and Fisher (2006):

- **Limestone Forests** are generally found growing on limestone substrates and consist of broad-leafed evergreen tree species, including wild breadfruit (*Artocarpus mariannensis*) and nunu (*Ficus* sp.) and in some areas by screw pine (*Pandanus* sp.). Other species may be locally dominant.
- **Ravine Forest** is a variable wet broad-leafed forest community commonly found in valleys and ravines in Southern Guam. It can also be found on Bonya and maemong limestone outcrops in the Talofofo drainage. Generally less diverse than limestone forest, this community is often dominated by *Hibiscus tiliaceaus*, *Pandanus tectorius, P. dubius, Ficus prolixa, Glochidion marrianennensis,* and *Premna obtusifolia*). Lemondichina (*Triphasia trifolia*) and bamboo (*Bambusa vulgaris*) are also known to occur, sometimes in dense thickets.
- **Scrub Forest** is a highly variable vegetation community that usually results from human intervention (disturbances). Scrub forest patches may be dominated by breadfruit (*Artocarpus* sp.), coconut (*Cocos nucifera*) groves, bamboo (*Bambusa vulgaris*) clumps, homesteads, agricultural fields, pastures, or tangantangan (*Leucaena leucocephala*) thickets.
- **Savanna Complex** contains several different types of grassland communities found on volcanic soils in southern Guam. These communities can be dominated by sword grass (*Miscanthus floridulus*) or *Dimeria chloridiformis*. Other grassland communities are found in association with erosion scars or “badlands” and contain the savanna pioneer species mana fern (*Gleichenia linearis*) and staghorn clubmoss (*Lycopodiella cernua*). Grassland communities that follow disturbance from soil grading, clearing, or agriculture

contain a variety of weedy forb[3] species. Tall reed (*Phragmites karka*) can form pure stands in wet savanna areas and are indicators of ponded water.

- **Marsh** consists of areas of standing water for most of the year, which are dominated by grasses, sedges, and herbs. These areas are typically dominated by *Phragmities karka*, a tall reed grass species.
- **Urban Built-up** is an area where the natural vegetation community has been removed and buildings, roads, or parking lots now occur.
- **Urban Cultivated** are areas typically associated with military installations, cities, or suburban areas, containing maintained landscape vegetation such as golf courses, lawns, athletic fields, etc.
- **Badlands** are areas without vegetation, typically in the savannas of southern and central Guam, caused by erosion as a result of vehicle or fire damage.
- **Barren** is an unidentified barren area.

3.2 Natural Environment and Threatened and Endangered Species Overview

3.2.1 Wetlands

Overall, wetland habitats are not extensive on Guam, but they are more widely distributed in the south than on the rest of the island. They can be perennial in nature, with surface water available throughout the year, or they can be seasonal. During extended wet seasons, the seasonal wetlands may hold water throughout the year and, conversely, during prolonged droughts even the perennial wetlands may dry up completely.

Two types of wetlands occur on the island, marshes and swamps. Marsh vegetation is primarily herbaceous (**Figure 9**); swamp vegetation (**Figure 10**) is more woody (Fosberg 1960). Based on the nature of the vegetation, Fosberg (1960) further subdivided the marshes as follows:

- **Reed marshes**, which are dominated by tall reeds (*Phragmites karka*) that form monospecific communities. This is the most common marsh type on the island.
- ***Scirpus* marshes**, which are dominated by bulrush (*Schonoeplectus littoralis*). These typically grow in thick monospecific and are usually associated with fresh or slightly brackish open waters.
- ***Paspalum* flats** are usually associated with brackish-water pools and are indicators of areas where water seeps from the ground during high tide. *Paspalum* flats are dominated by the mat-forming grass, *Paspalum vaginatum*.
- ***Panicum* flats** are similar to *Paspalum* flats but instead are dominated by *Panicum purpurascens*. They are typically found in more freshwater areas than are *Paspalum* flats. *Panicum purpurascens* was brought to Guam as a forage grass and therefore *Panicum* flats are often seen in low areas of pasture land.
- Miscellaneous marsh types that do not easily fit within the above categories.

[3]A forb is a herbaceous, flowering, non-grass species.

Figure 9: Herbaceous Vegetation-Dominated Marsh Wetlands in the LFTRC Study Area

Figure 10: Woody Vegetation-Dominated Swamp Wetlands in Guam

Based on the vegetation types, Fosberg (1960) also divided swamps into the following:

- **Mangrove swamps**, which are typically found along coastal areas of Guam. These are generally dominated by mangroves and other salt-tolerant species.
- **Nypa swamps** are also limited in distribution and are found at the mouths of several rivers in southeast Guam. Nypa swamps are dominated by Nipa palms (*Nypa fruticans*).
- **Barringtonia swamps** are unique to Guam and are only found along the Talofofo River (Fosberg 1960). The dominant species is *Barringtonia racemosa*, which forms a closed-canopy monoculture with no understory. Trees grow on elevated areas within the wetland and are separated by channels which may be muddy or contain water.
- ***Hibiscus tiliaceus* swamp** is dominated by its namesake species, known as Pago in the local Chamorro language, and is common in the Talofofo Watershed.
- Where Pago co-dominates with *Pandanus tectorius*, *Hibiscus-Pandanus* swamp occurs. This swamp type often forms mosaics with *Barringtonia* swamp and reed marsh. It is found east of Mount Lam Lam within the NMS.
- Specific wetland types that occur within the proposed LFTRC range footprints are discussed in **Section 3.6**, **Table 11**).

3.2.2 Wildlife

Five native bird species currently occur on Guam: the Mariana common moorhen (*Gallinula chloropus guami*), Mariana swiftlet (*Aerodramus vanikorensis bartschi*), Micronesian starling (*Aplonis opaca guami*), yellow bittern (*Ixobrychus sinensis*), and Pacific reef heron (*Egretta sacra*)[4]. The first two are federally and GovGuam-listed endangered species. The starling is a Guam-endangered species. The last two are commonly found on the island (JRM 2013); neither species is listed as threatened or endangered, but both are protected by the Migratory Bird Treaty Act (MBTA). The yellow bittern is the only native land bird that is still considered to be common on Guam (U.S. Navy 2009). Four of the five native species (Mariana common moorhen, Mariana swiftlet, yellow bittern, and Pacific reef heron [see Pratt et al. 1987 and Glass et al. 1990]) may potentially occur within the study area.

The Guam-endangered white-throated ground dove (*Gallicolumba xanthonura*), long considered extirpated on the island, has in recent years been observed in some areas on the island including the Talofofo Watershed (Division of Aquatic and Wildlife Resources [DAWR] 2006). Historically this species was found in all habitats on Guam. Though the species is extirpated on Guam and was last seen in 1987 in northern Guam, there were sightings of 2 males in 2003 in Andersen Air Force Base and another sighting of a male in January 2005, flying along the Talofofo ridgeline on southern Guam. The three sightings are presumably of birds from nearby Island of Rota. (JRM 2013).

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[4]Note that the Mariana crow (*Corvus kubaryi*), which until recently was listed as extant in Guam, is now considered to be extirpated from Guam. There are no crows left in the wild on the island. The latest official word on this issue comes from Jeremy Adams, AAFB Natural Resources Specialist, July 9, 2012, based on the *Final Summary Report: Noise Study And Demographic Survey Of Mariana Fruit Bats And Mariana Crows, Andersen Air Force Base, Guam* (SWCA, 2012), which states that “Kahit was last observed in MSA-1 in July of 2011.”

Several species of sea birds and shore birds are also frequently observed around Guam, and additional species stop over during migration. These *non-native* species may make use of the FVR and other wetland habitats within the study area. Other *non-native* bird species that may potentially occur in the study area include the island collared dove (*Streptopelia bitorquata*), Eurasian tree sparrow (*Passer montanus*), black francolin (*Francolinus francolinus*), and black drongo (*Dicrurus macrocercus harterti*).

The *native* mammalian fauna of Guam consisted of three bat species. Of these, only the Mariana fruit bat (*Pteropus mariannus mariannus*) remains on the island, persisting in low numbers. These bats are occasionally observed in the NMS (JRM 2013) and therefore may also occur in the study area. *Non-native* mammals that may use the study area include Philippine deer (*Cervus mariannus*), carabao (Asian water buffalo, *Bubalus bubalis*), Indian musk shrew (*Suncus murinus*), feral pigs (*Sus scrofa*), dogs (*Canis familiaris*), and cats (*Felis catus*) (JRM 2013).

Eleven *native* terrestrial reptile species currently occur on Guam (NAVFAC 2013). The following 8 of these 11 species are listed as Guam-endangered: snake-eyed skink (*Cryptoblepharus poecilopleurus*), tide-pool skink (*Emoia atrocostata*), azure-tailed skink (*Emoia cyanura*), Slevin's skink (*Emoia slevini*), moth skink (*Lipinia noctua*), oceanic gecko (*Gehyra oceanica*), Micronesian gecko (*Perochirus ateles*), and Pacific slender-toed gecko (*Nactus pelagicus*) (JRM 2013).

Of the eight Guam-endangered terrestrial reptiles, the tide-pool, snake-eyed, and azure-tailed skinks are known to occur only on Cocos Island off the southern coast of Guam. They are not expected to occur within the study area. Based on habitat types that are present, the other five Guam-endangered terrestrial reptile species may potentially utilize the study area.

Other reptiles commonly found on Guam and which may also potentially occur in the study area include the *native* blue-tailed skink (*Emoia caeruleocauda*), mangrove monitor (*Varanus indicus*), house gecko (*Hemidactylus frenatus*), mourning gecko (*Lepidodactylus lugubris*), and mutilating gecko (*Gehyra mutilata*), and the *non-native* brown treesnake (*Boiga irregularis*), Brahminy blind snake (*Ramphotyphlops braminus*), and curious skink (*Carlia fusca*). In addition, three *non-native* turtles have been observed in the FVR, the red-eared slider (*Trachemys scripta elegan*), soft-shell turtle (*Pelodiscus sinensi*), and common snapping turtle (*Chelydra serpentina*) (Christy et al. 2007).

Guam has no *native* amphibians; however several *non-native* amphibians are known to be present on the island, including the marine toad (*Bufo marinus*), greenhouse frog (*Eleutherodactylus planirostris*), eastern dwarf tree frog (*Litoria fallax*), Guenther's Amoy frog (*Rana guntheri*), Hong Kong whipping frog (*Polypedates leucomystax*), grass frog (*Fejervarya* cf. *limnocharis*), crab-eating frog (*Fejervarya cancrivora*), and marbled pygmy frog (*Microhyla pluchra*) (Christy et al. 2007). Based on habitat types that are present, one or more of these *non-native* amphibian species may potentially occur in the study area.

Several Federal candidate and Guam-endangered invertebrates are known to occur on the island, including the Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*), Guam tree snail

(*Partula radiolata)*, humped tree snail (*Partula gibba*), and fragile tree snail (*Samoana fragilis*). Based on habitat types that are present, all four invertebrate species may potentially occur within the study area.

3.2.3 Threatened, Endangered and Candidate Species

Under the Federal Endangered Species Act (ESA) of 1973, a species that is in danger of going extinct throughout all or a significant portion of its distribution range is defined as "*endangered*." Species which are likely to become endangered in the foreseeable future throughout all or a significant portion of their distribution range are characterized as "*threatened*." Species that are currently under consideration for listing as endangered or threatened are designated as "*Candidate*" species.

The ESA of Guam (5 Guam Code Annotated 63208, P.L. 15-36) authorizes the conservation and management of threatened and endangered species to achieve the purposes of the Federal ESA. Accordingly, any species which is in danger of extirpation on Guam (as determined by the Guam Department of Agriculture [GDA]) or has been designated as an endangered species under the federal ESA is also designated as an endangered species under the Guam ESA. Similarly, any species that appears likely within the foreseeable future to become endangered (as determined by GDA) or has been designated as a threatened species under the federal ESA, is also characterized as a threatened species under the Guam ESA.

Ten terrestrial species occurring in Guam, which includes one plant species, are listed as endangered under the Federal ESA (**Table 6)**. Of these species, the little Mariana fruit bat (*Pteropus tokudae*) and the Guam bridled white-eye (*Zosterops conspicillatus conspicillatus*) are likely extinct. The Guam Micronesian kingfisher (*Halcyon cinnamomina cinnamomina*), Micronesian megapode (*Megapodius laperouse*), Mariana crow (*Corvus kubaryi*), and the nightingale reed-warbler (*Acrocephalus luscina*) have been extirpated from the island. The Guam rail (*Gallirallus owstonii*), also endemic to Guam, was once extirpated, but has been released back into the wild on Cocos Island off the southern coast of Guam and the island of Rota in the CNMI (USFWS 2012).

Of the remaining three federally listed endangered species, the Mariana common moorhen (*Gallinula chloropus guami*) and Mariana swiftlet (*Aerodramus bartschi*) are known to be present within the boundaries of the NMS (JRM 2013) and therefore may be present within the study area. The federally listed endangered species hayun-lago (*Serianthes nelsonii*), a tree known to typically grow on limestone soils, persists as a single mature tree in northern Guam (six saplings from a 1990 outplanting also survive in northern Guam [JRM 2013]). The majority of the known species distribution occurs on Rota in the CNMI. Given the expanse of hard-to-access areas of ravine and limestone forest on NMS, it is possible that hayun-lago may persist within the NMS and also the study area.

The only federally listed threatened terrestrial species in Guam, the Mariana fruit bat, may potentially utilize the study area[5]. Four invertebrate species, which are candidates for federal

[5]Biologists from Naval Base Guam, Public Works have recently (2012) reported sightings of Mariana fruit bats flying close to Fena reservoir in the area of East Kitts and Fena Valley Roads in the early morning just after dawn.

listing—Guam tree snail, humped tree snail, fragile tree snail, and Mariana eight spot butterfly—also have the potential to occur in the study area.

Thirty terrestrial species are listed as endangered under the Guam ESA. This list includes twelve bird, eight reptile, three plant, four mollusk, and three mammal species. Four of these species, the Guam flycatcher (*Myiagra freycineti*), Guam bridled white-eye, little Mariana fruit bat, and Alifan tree snail (*Partula salifina*) are considered extinct.

The Micronesian starling is not likely to be present in the study area. The white-throated ground dove is considered extirpated, but a few individuals may be present in the study area (DAWR 2006). The remaining Guam-endangered bird species have been extirpated from Guam and occur only in captive populations, in experimental populations outside of Guam, or as wild populations on other islands in the Mariana Archipelago. Suitable habitat for these species occurs within the study area.

Eight native reptiles are listed as Guam-endangered species, including the snake-eyed skink, tide-pool skink, azure-tailed skink, Slevin's skink, moth skink, Pacific slender-toed gecko, oceanic gecko, and Micronesian gecko. Snake-eyed, tide-pool, and azure-tailed skinks are only known from Cocos Island off the south coast of Guam. Moth skinks and Pacific slender-toed geckos were found on NMS during surveys in 2010 (DoN 2010) and are expected to be present within the study area.

Three native plants are listed as Guam-endangered species, the tree fern known as tsatsa (*Cyathea lunluata*), the limestone and ravine forest tree hayun-lago (*Serianthes nelsonii*), and the limestone forest tree Ufa-halomtano (*Heritiera longipetolata*). Tsatsa is known to be present on the savanna and ravine forest slopes in the western portion of NMS. Several adult tsatsa were observed from the summit of Jumullong Manglo in the study area (estimated location 55 P 248194 E, 1474786 N, WGS 84) during this reconnaissance survey. Ufa-halomtano is also reported to be present within the study area (DoN 2010). As stated earlier, hayun-lago is not known to occur within the study area, but natural areas that could potentially support occurrence of this tree species are present.

Three Guam-endangered tree snails survive on Guam. The Guam tree snail is known to occur within the study area and two populations of this species were also observed by Smith et al. (2008) along Kitts Road. Suitable habitat for the humped tree snail (*Partula gibba*) and fragile tree snail (*Samoana fragilis*) also occurs within the study area.

3.3 Surface Hydrology, Geology, and Soils Overview

The potential for soil erosion, sediment (and contaminant) mobilization by stormwater runoff, and offsite flooding is primarily influenced by the combined interaction between key parameters such as surface hydrology, geology, soils, topography, and prevailing LULC. Existing conditions in the Talofofo and Ugum Watersheds for some of these key parameters are described below.

Note for the purpose of this characterization, the Talofofo Watershed is divided into three sections based on hydrologic divides—northern, central, and southern.

Table 6: Guam and Commonwealth of the Northern Mariana Islands Animals & Plant Listed Species, As Designated Under the U.S. Endangered Species Act[a]

(Updated February 2, 2011)

Scientific Name (Genus Species)	Common Name[b]	Listing Status	Distribution	
			Guam	**CNMI**
Pteropus tokudae	Bat, Little Mariana Fruit (Fanihi)	Endangered	X[c]	--
Pteropus mariannus mariannus	Bat, Mariana Fruit (Fanihi)	Threatened	X	X
Acrocephalus luscinia	Reed-Warbler, Nightingale (Ga'ga' Karisu)	Endangered	X[c]	X
Aerodramus bartschi	Swiftlet, Mariana (Yayaguak = Guam) (Chachaguak = CNMI)	Endangered	X	X
Corvus kubaryi	Crow, Mariana (Aga)	Endangered	X[d]	X
Gallinula chloropus guami	Moorhen, Mariana Common (Pulattat)	Endangered	X	X
Todiramphus [Halycon] cinnamominus	Kingfisher, Guam Micronesian (Sihek)	Endangered	X[c]	--
Megapodius laperouse	Megapode, Micronesian (Sasangat)	Endangered	X[c]	X
Gallirallus owstoni	Rail, Guam (Koko)	Endangered	X	X[e]
Zosterops conspicillatus conspicillatus	White-eye, Guam Bridled (Nosa)	Endangered	X[c]	--
Chelonia mydas	Turtle, Green Sea (Haggan)	Threatened	X	X
Eretmochelys imbricata	Turtle, Hawksbill (Haggan Karai)	Endangered	X	X
Serianthes nelsonii	(Hayun Lagu = Guam) (Tronkon Guafi = Rota)	Endangered	X	X

Source: USFWS (2011)

[a]Only includes species utilizing terrestrial resources (e.g., turtle nesting on beaches)
[b]Chamorro names are in parenthesis
[c]Extirpated in the wild from Guam
[d]The Mariana crow, which until recently was listed as extant in Guam, is no longer considered to be present. There are no crows left in the wild on the island.
[e]A non-essential experimental population was designated for this species on the island of Rota, CNMI.

The proposed range footprints associated with the three alignments are mostly confined to either the northern or the southern portions of the Talofofo watershed. The SDZ's of several proposed range footprints extend into the central Talofofo Watershed.

3.3.1 Northern Talofofo Watershed (NTW)

3.3.1.1 Surface Hydrology

The NTW is drained by the Talaeyuus River which is formed by the confluence of the Maemong, Talisay, and Bonya Rivers (**Figure 11**). The Maemong River drains the northernmost portion of the NTW, and is fed by multiple unnamed, smaller tributaries. The Talisay River drains the eastern slopes of Mount Alifan, flows east through the NMS, and joins the Maemong River. The Bonya River drains the southern portion of the NTW, and it also flows to join the Maemong before its confluence with the Talaeyuus River.

The Talaeyuus River is also known as the Lost River because it flows for a short distance before disappearing below limestone formations. It reappears downstream of the FVR and joins the Maagas River. The Talaeyuus drainage basin is almost entirely contained within the NMS.

3.3.1.2 Geology

Three geologic formations, Alifan limestone, Talisay member, and Alutom formation, underlie the majority of the NTW. Alifan limestone is found predominantly to the west on elevated topography around Mount Alifan. Additional isolated outcrops can be found further to the east in the study area, but the largest outcrops are still west of Parson's Road (**Figure 5**). The Talisay member and Alutom formation form the majority of the NS-Alignment in the study area.

3.3.1.3 Soils

Soils series occurring within the NTW include the Akina, Ritidian, and Inarajan. The Akina series soils, with slopes from 7 to 30 percent, are the most prevalent, and they occur within the proposed MRF, Small Arms, most of the KD, and half the HG Range footprints. The Ritidian soil series, with slopes from 3 to 60 percent, are found on the western side in the area proposed for locating the MPMG Range footprint. The flat areas in the NTW hold Inarajan clay soil with 0 to 4 percent slopes, and they occur in the area proposed for locating all other NS-Alignment Ranges including the Pistol Range. Steep Akina-Atate soils are found in the downrange dispersion areas of the SDZ of many of the proposed range footprints. See **Section 1.4** for a discussion of the SDZ and dispersion areas.

3.3.2 The Central Talofofo Watershed (CTW)

3.3.2.1 Surface Hydrology

The most prominent hydrologic feature in the CTW is the FVR (**Figure 11**). This watershed is drained by Imong, Almagosa, and the Maulaup Rivers. The Imong flows from the southwest to northeast and enters the FVR at its southern end. Multiple small tributaries feed the Imong with the Sadog Gago being the largest. The Almagosa River drains the eastern slope of Mount Lam

Lam, the highest point on the island, and enters the FVR in the southern portion. The Maulaup River runs east and enters the FVR in the middle region. The Maagas River originates below the FVR discharge spillway.

3.3.2.2 Geology

The CTW is dominated by the Dandan flow member in the northern portion of the watershed and Alifan limestone west of the Dandan flow member. South of the Dandan flow member and Alifan limestone, the watershed is dominated by Bolanos pyroclastic member. The Almagosa Sink is located in the CTW and contains alluvium consisting of marshy estuarine deposits and surrounded to the north, east, and west by Alifan limestone and on the south by Bolanos pyroclastic member. No range footprints occur within the CTW. However, the dispersion areas of the SDZ for some of the ranges do extend into the CTW.

3.3.2.3 Soils

The CTW is largely characterized by soils from the Akina-Atate series, and the Akina-Agfayan associations are the most common. Ritidan soil units are found along the western boundary of the watershed, high along the island divide. Areas of Akina-Badland association are scattered along the ridges of the southern mountains. Akina-Atate silty clays of 7 to 60 percent slope define the eastern portion of the watershed just upslope of the FVR.

3.3.3 Southern Talofofo Watershed (STW)

3.3.3.1 Surface Hydrology

The STW is drained by the Talofofo River, which is formed by the merger of the Maagas and Mahlac Rivers (**Figure 11**). The Maagas River receives flow from the Talaeyuus River before merging with the Mahlac to form the Talofofo River. The Maagas and Mahlac Rivers drain the northern portion of the STW. The southern portion of the STW is drained by the Tinechong, Sagge, and Sarasa Rivers. These three rivers drain the savanna grassland located to the east of the reservoir, and they eventually drain to the Talofofo River. The majority of the drainage area of these three rivers is located on privately-owned lands. The Pagunon and the Ugum rivers are the last major tributaries before the Talofofo River discharges into the Talofofo Bay.

3.3.3.2 Geology

The STW is dominated almost exclusively by Bolanos pyroclastic member within the study area. Alluvium deposits are found along the river floodplains east of the study area. Scattered small areas of the Dandan flow member can be interspersed with the Bolanos pyroclastic member in the study area. Proposed range footprints of the EW- and L-Alignments in the STW are located in Bolanos pyroclastic member.

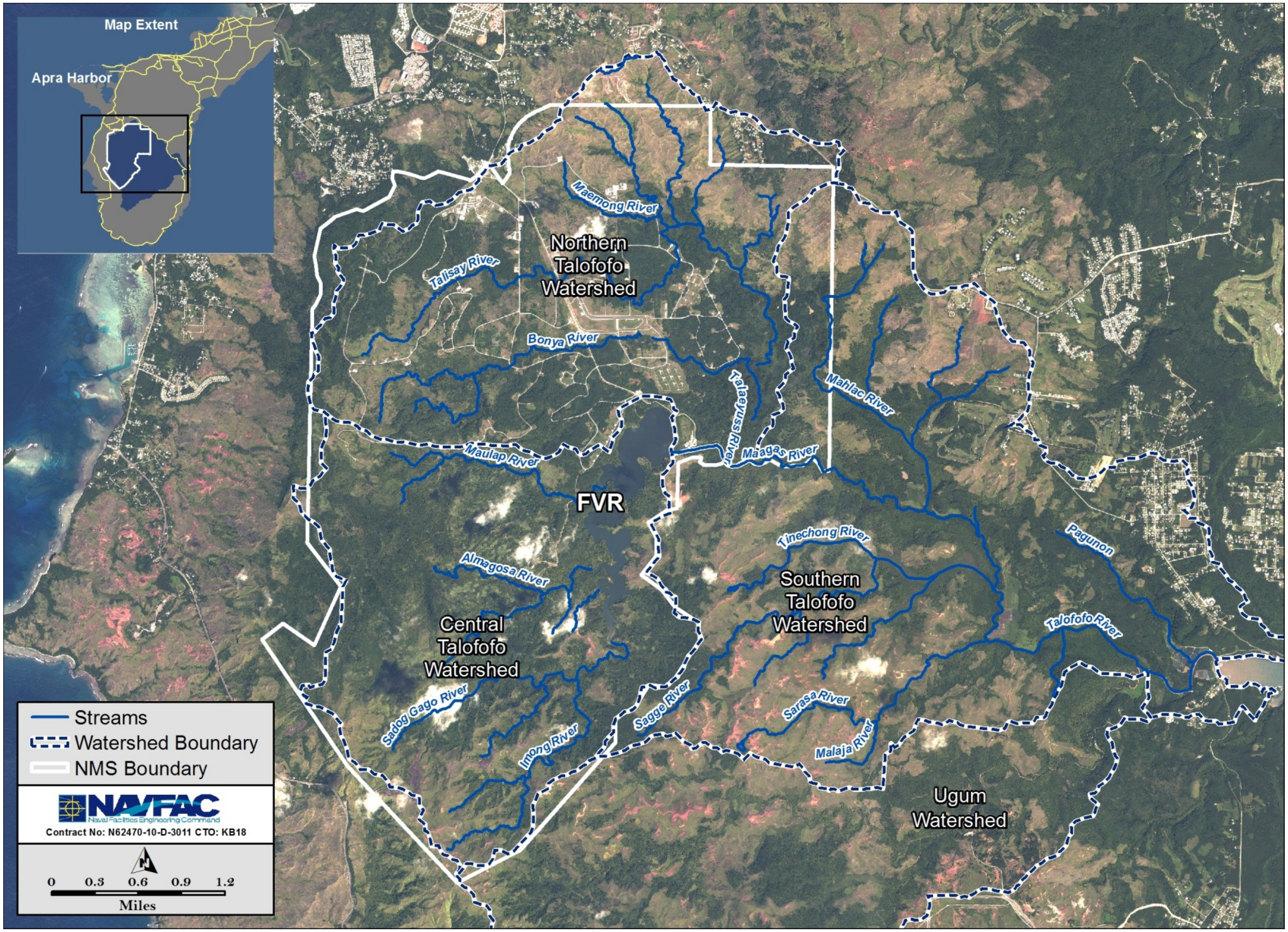

Figure 11: Talofofo Watershed Surface Hydrology

3.3.3.3 Soils

While the geologic formations of the STW are fairly consistent across the study area, the soil types are varied and include Togsha-Akina, Akina, Akina badland, Akina-Atate, and Ylig clay, with slopes ranging from flat to 60 percent. The most common soil type in the STW underlying the proposed range footprints is Akina-Atate silty clays with slopes from 15 to 30 percent; these occur within the proposed L-Alignment KD, HG, Pistol, and Small Arms Range footprints. The areas proposed for locating the EW-Alignment Ranges are located farther to the east on Togsha-Akina, Akina badland, and Ylig clay soils of slopes varying from flat to 30 percent.

3.3.4 Ugum Watershed

3.3.4.1 Surface Hydrology

The Ugum Watershed, which lies to the south of the Talofofo Watershed, is primarily drained by the Ugum River, which is formed by the confluence of the Bubulao River and many unnamed smaller tributaries (**Figure 12**). The Ugum River runs northeast and joins the Talofofo River just before it discharges into Talofofo Bay. The Ugum Watershed is dominated by privately-owned lands. Guam Water Authority operates a surface water diversion in the lower Ugum River, which serves as a source of freshwater supply for southern Guam.

3.3.4.2 Geology

Only the proposed L-Alignment MRF Range footprint extends into the Ugum Watershed. This area is primarily composed of Bolanos pyroclastic member.

3.3.4.3 Soils

Several different soil types, including Akina-Atate silty clays, with slopes from 15 to 60 percent, and Akina badlands and Tocha-Akina silty clays, with slopes from 3 to 15 percent, occur within the proposed L-Alignment MRF Range footprint.

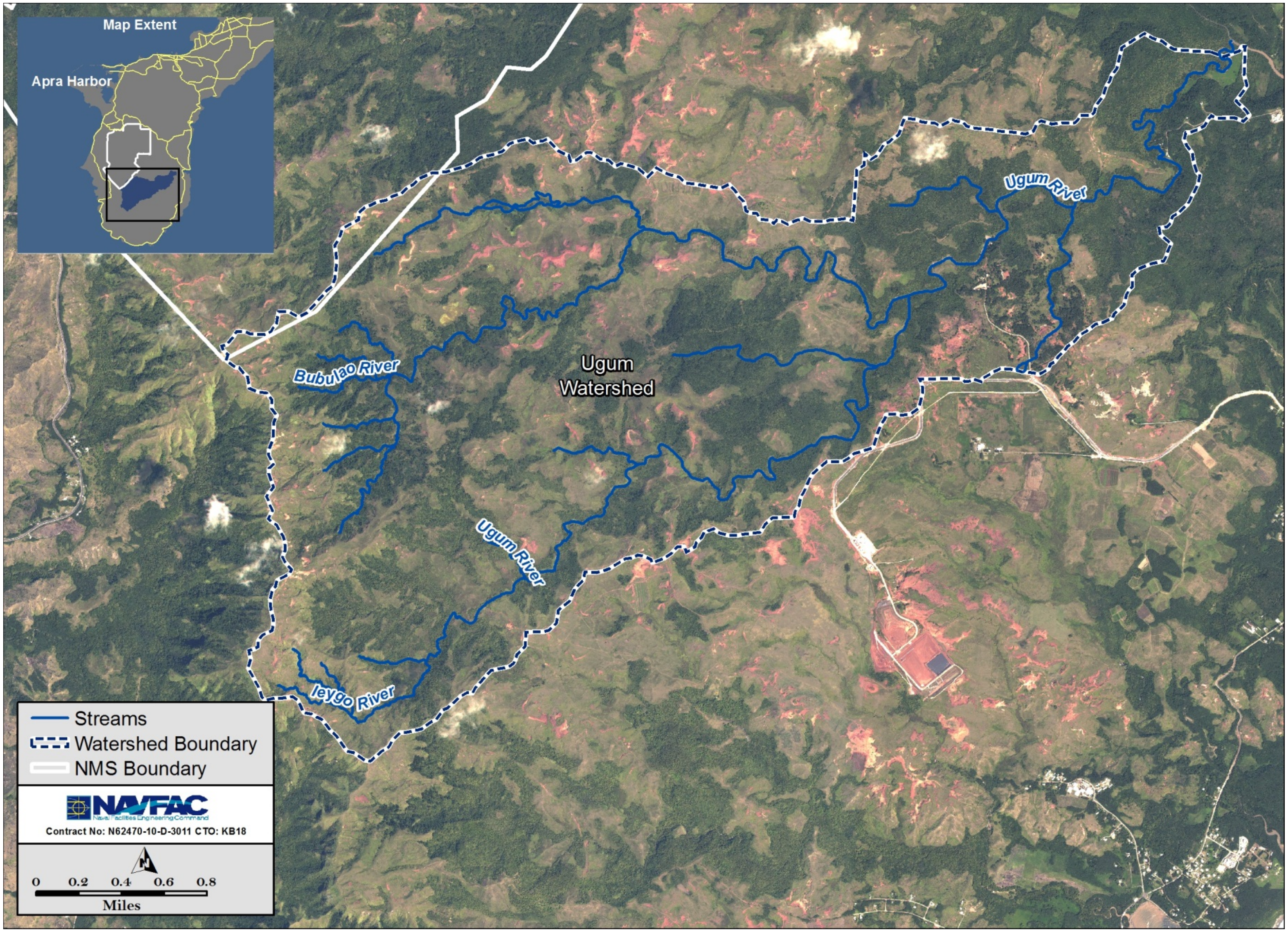

Figure 12: Ugum Watershed Surface Hydrology

3.4 LFTRC Alignment Characterization

For each of the three alignments being evaluated in the SEIS, issues related to surface hydrology and flooding potential, soil erosion and sediment transport, soil geochemistry (which influences lead mobilization), and threatened and endangered species are discussed below:

3.4.1 NS-Alignment

3.4.1.1 Surface Hydrology and Flooding Potential

The NS-Alignment proposed ranges are spatially located along and over numerous major and minor watercourses of the NTW (**Figure 5**). The first major drainage is the Talisay River, which will receive runoff from the areas proposed for locating the KD Rifle, HG, MPMG, MRF, and the northern portion of the Small Arms ranges. The Talisay system includes numerous, unmapped, intermittent tributaries, which often connect the wetland features of the area. In the areas proposed for locating the various range footprints, the Talisay transitions from a steep and incised channel, exhibiting step pool characteristics, to an undefined, wide, flooded swamp, becoming narrow only where it passes through road culverts.

The Bonya River is the second major drainage system that may potentially be impacted by NS-Alignment (**Figure 13**). This river drains the remaining portion of the Small Arms Range, as well as the Pistol Ranges. The channel in this reach is confined by topography and appears to be fairly stable, with few signs of recent bank erosion, and travels through heavily forested terrain. Areas of exposed bedrock have eroded to smooth forms.

The Talisay River has a Federal Emergency Management Agency (FEMA) Zone A Special Flood Hazard Area, in this case a floodplain, mapped downstream of the proposed ranges (**Figure 14**). However, this does not necessarily preclude flooding from occurring along the sections of the river that lie in the vicinity of the proposed ranges. Similar to the Talisay River, the Bonya has a FEMA-designated Zone A floodplain mapped well below the proposed range footprints.

Figure 13: Bonya River

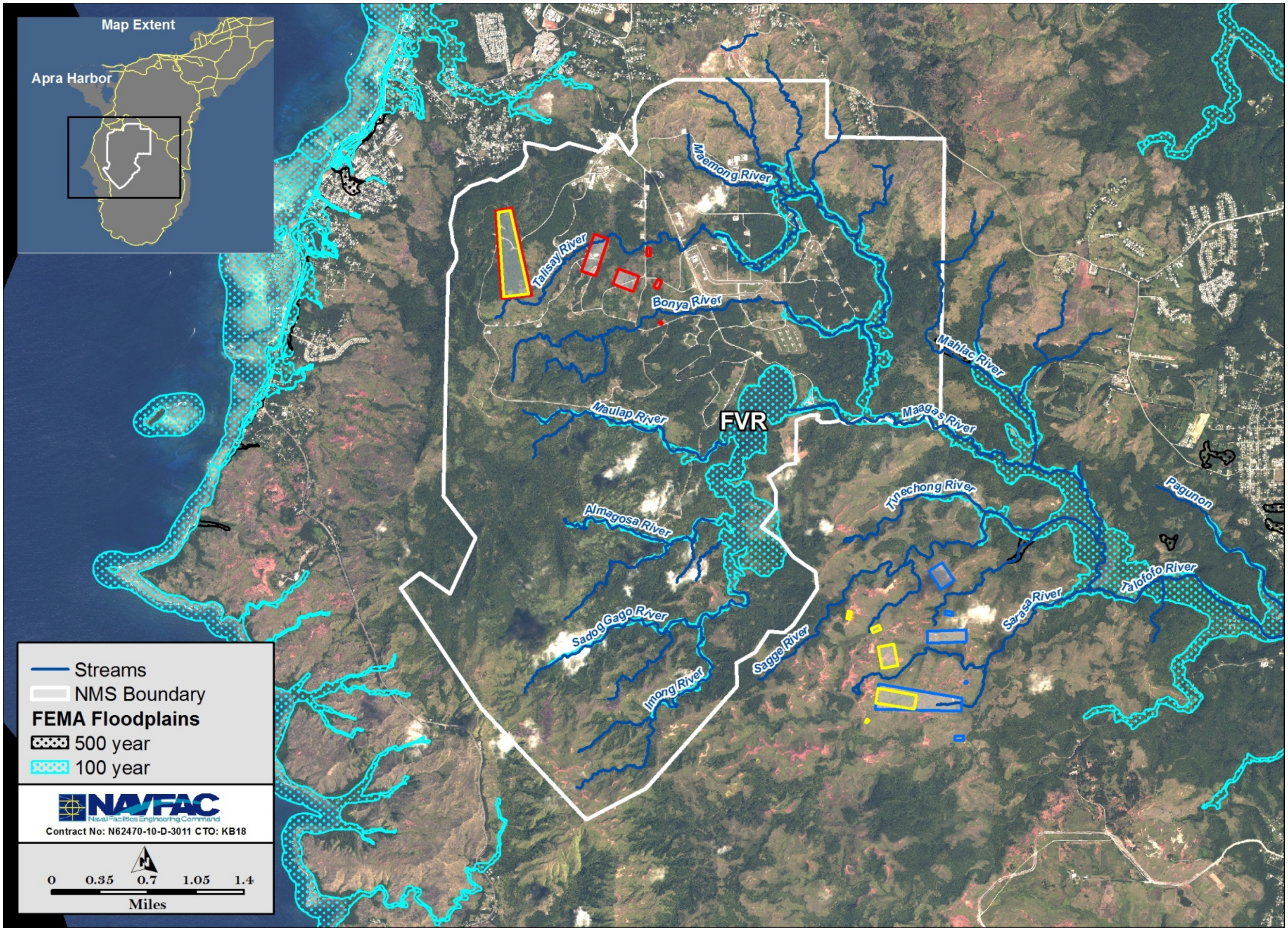

Figure 14: LFTRC Study Area FEMA Special Flood Hazard Areas

3.4.1.2 Soil Erosion Potential

The proposed NS-Alignment Ranges are generally located on soils with naturally lower soil erosion potential as compared to the L- and EW-Alignments. Also, these areas are covered with dense vegetation, which further reduces the likelihood of soil erosion. During the site visit, a few signs of ongoing erosion were observed on some of the landscaped bunkers and associated berm areas (**Figure 15**) most likely resulting from loss of vegetative cover.

Figure 15: Berm Showing Early Signs of Erosion

Soil disturbances resulting from ungulate (pigs, carabao, and deer) activity appears to be one of the major potential sources of soil erosion in this area. Numerous ungulates were observed during the site visit. Persistent feeding and grazing creates well-worn trails that do not support vegetation and are therefore susceptible to getting eroded. These activities also strip the understory, which results in loss of natural erosion control. The animals also regularly trample and dig in the soil for roots and tubers, which aggravates soil particle release. The photo in **Figure 16** shows a Carabao trail coming off a hillside and entering the Bonya River. Note the large amount of sediment poised to enter into the river channel.

Figure 16: Carabao Trail along the Bonya River in the NMS

3.4.1.3 Soil Geochemistry (Lead Mobilization Potential)

Mobilization of soil-accumulated lead into stormwater runoff is largely mediated by two main soil properties, pH and Cation Exchange Capacity (CEC). The CEC is a calculated value that provides a measure of the soils ability to attract, retain, and exchange cationic elements such as lead. It is generally reported in millequivalents per 100 grams of soil (meq/100g). **Generally a soil with a higher pH (or close to neutral) and a lower CEC will hold on to the lead cations more strongly, making them less likely to be mobilized by the stormwater runoff**. In other words, a higher soil pH and lower CEC theoretically equates to a lower likelihood of lead migration via surface water runoff.

Soil pH and CEC values for the proposed NS-Alignment Ranges (footprint and the downrange dispersion area) are presented in **Table 7**. The average pH and CEC values for the footprint areas are 5.8 and 30.5 meq/100g, respectively compared to an average pH and CEC values of 5.5 and 28.7 meq/100g, respectively for the dispersion areas.

At a firing range, lead mobilization is of greater concern within the actual range footprint than the dispersion area (which may only receive stray bullets). For the NS-Alignment as a whole, the footprint areas appear to be characterized by slightly higher pH and CEC values, which implies both a greater and lesser capacity for lead migration. Compared to the other two alignments, the NS-Alignment has the higher pH and lower CEC values.

Table 7: NS-Alignment – Soil Geochemistry Characterization for Lead Mobilization Potential

	Average pH	Average CEC (meq/100g)
Firing Range Area		
HG	5.6	35.4
KD Rifle	5.7	34.2
MPMG	6.7	26.9
MRF	5.0	28.0
Pistol	5.0	28.0
Small Arms	5.0	28.0
NS-Alignment as a whole	5.8	30.5
Dispersion Area		
HG	6.1	39.6
KD Rifle	5.5	29.2
MPMG	5.6	28.2
MRF	5.6	28.2
Pistol	5.1	28.9
Small Arms	5.5	28.7
NS-Alignment as a whole	5.5	28.9

3.4.1.4 Fire Susceptibility

Presence of a vegetative cover provides soil with natural erosion protection. If this cover is lost, due to a forest fire for example, then the potential for soil erosion increases substantially. The NMS is characterized by dense forest vegetation, a significant road network, and restricted access. These three factors together contribute to a lower risk of arson fires, which plague many of the other upland, savanna-grassland dominated watersheds in Guam.

The presence of a munitions storage facility within the NMS boundaries and the need to protect property aboard the installation necessitates a few proactive measures such as (1) appropriate structural fire-prevention measures (fire breaks exist in some locations on NMS), (2) effective fire-suppression policies (no smoking or open-air camp fires) are in place and strictly enforced, and (3) the installation can move quickly to respond to accidental fires. The draft Wildfire Management Plan for Navy Lands (Nelson 2005), indicates a fire engine and fire-fighting company of seven firefighters is located on NMS.

Since all NS-Alignment Ranges are proposed to be located either on or very close to the NMS, it can be assumed that the risk of the barren soils due to arson or natural forest fires is relatively low.

3.4.1.5 ESA Issues

The proposed footprints for the NS-Alignment Ranges include natural areas that may potentially be used by several different federally and Guam-listed species (DoN 2010), including the Mariana fruit bat, Mariana swiftlet, and Mariana common moorhen,. The Mariana common moorhen and swiftlet are federally and Guam-endangered, and the Mariana fruit bat is federally threatened and Guam-endangered. Collectively, approximately 84 ac of habitat that could potentially be used by sensitive species occurs within the proposed range footprints.

No large fruit bat colonies have been recorded on the NMS since census efforts began in 1962 (JRM 2011), and only rare observations of this bat species have been recently reported on the NMS (JRM 2011). If the NS-Alignment is evaluated further, it is recommended that such evaluations include a baseline Mariana fruit bat survey to determine the current population size and distribution within the study area.

The federally and Guam-endangered Mariana common moorhen is known to be present in the NMS (JRM 2011). Surveys conducted by Takano in the dry season of 2001 determined that 38 of the 90 birds estimated to be present on Guam occurred in the NMS (Takano and Haig 2004). Most of those birds (33) used the FVR as habitat. Moorhen numbers have declined at FVR since the loss of the introduced water plant hydrilla (*Hydrilla verticillata*) following a typhoon in 2001, and the current population and distribution in the NMS is not well understood. During the site reconnaissance visit three moorhens were observed in a small open-water wetland near the intersection of Parsons and Hardstand roads. If the NS-Alignment is evaluated further, it is recommended that such evaluations include moorhen surveys in all seasonal and perennial marsh, swamp, and open-water wetland habitats within and adjacent to all proposed NS-Alignment Range footprints in order to better characterize the population and distribution of moorhens.

The federally and Guam-endangered Mariana swiftlets occupy three nesting caves that are located on the border between the NTW and the STW. These caves are situated to the east of the areas proposed for the NS-Alignment Range and are well outside the proposed footprint boundaries (including the SDZ areas). The primary foraging area for these swiftlets, however, generally extends east from the FVR spillway into the STW (Morton and Amidon 1996). It is possible that the birds may also use portions of the savannas and ravine forests within the proposed NS-Alignment Range footprints for foraging purposes. If the NS-Alignment is evaluated further, it is recommended that such evaluations include a determination of the extent to which this area contributes to the overall foraging area for the Mariana swiftlet.

Five Guam-endangered lizards (Slevin's skink, moth skink, slender-toed gecko, oceanic gecko, and Micronesian gecko) have the potential to occur in the areas proposed for locating the NS-Alignment Ranges. Slender-toed geckos and moth skinks were observed in the CTW region of the NMS during surveys conducted in 2008-2009 (DoN 2010). Potential native lizard habitat is present within the proposed NS-Alignment footprints. Surveys are recommended in limestone and ravine forest habitats to determine if native Guam-endangered lizards use this area.

Three species of native tree snails were recorded on Mt. Alifan in 1921 by Crampton (1925), including the humped tree snail, Guam tree snail and the Alifan tree snail (*Partula salifana*). The latter species was believed to be endemic to the central highland area around Mount Alifan. Surveys conducted by Hopper and Smith (1992) did not find live tree snails in the Mount Alifan area and the Alifan tree snail is now considered extinct. Surveys conducted in the NMS by Smith et al. (2008) detected two populations of Guam tree snails along Kitts Road, which is located close to the proposed NS-Alignment Range footprints. Additional potential tree snail habitat is present in limestone and ravine forest areas that lie within the proposed footprints. These areas were not covered in the surveys conducted by Smith et al. (2008). Additional tree snail surveys are recommended in limestone and ravine forest habitats within and adjacent to NS-Alignment footprints if this alternative is evaluated further.

The Federal candidate Mariana eight-spot butterfly can be found in limestone forest habitats where their larval-host plants, *Elatostema calcareum* and *Procris pedunculata*, are present. Adult butterflies may also occur in other habitat types adjacent to limestone forest containing larval-host plants. Limestone forests are present on the western extent of the NS-Alignment. Surveys are recommended to determine if the Mariana eight-spot butterfly host plants are present. If the host plants are present, additional surveys are recommended around the host plant patches to determine if the host plant is occupied by Mariana eight-spot larvae or if adult butterflies are present in the area.

Potential habitat for the Guam-endangered ufa-halomatano (limestone forest, often on cliff exposures), and Tsatsa trees (ravine forests or muddy savanna drainages in the southern hills of Guam (DAWR 2006) occurs within the areas proposed for locating the NS-Alignment Ranges If the NS-Alignment is evaluated further, it is recommended that such evaluations include vegetation surveys at least in the habitats identified above.

3.4.2 EW-Alignment

3.4.2.1 Surface Hydrology and Flooding Potential

The areas proposed for the EW-Alignment Ranges are spatially located along the Sagge, Sarasa, and Malaja river systems of the STW, as well as the Bubulao River of the Ugum Watershed.

The MRF Range drains to the Sagge River and one of its major unnamed tributaries. This unnamed tributary, located south of the Sagge River, also receives flows from the areas proposed for locating the HG and KD Rifle ranges (**Figure 6**). Review of aerial imagery and topographic data suggests that the flows from these areas are channeled by a mildly sloped stream that travels through a vegetation-choked wetland. The rest of the area proposed to be occupied by the KD Rifle Range drains through a wetland area to the Sarasa River.

The Malaja River flows almost through the center of the proposed MPMG Range footprint and drains almost the entire footprint area. Review of aerial imagery suggests that the channel appears to have formed a gully which transitions into a confined wetland area between two steeper hillsides. A low-flow channel free of vegetation is observed in the aerial photographs. A small corner of this range drains to the Bubulao River of the Ugum watershed.
The Small Arms Range is located entirely within the contributing area of the Bubulao River, located just upslope of its meandering channel.

The Sagge, Sarasa, and Bubulao rivers all have Zone A FEMA mapped floodplains (**Figure 14)**. However, none extend to the upstream reaches adjacent to the range footprints. This indicates that no inundation limits or flooding risk has been assessed in these areas.

3.4.2.2 Soil Erosion Potential

The areas proposed for locating the EW-Alignment ranges are all extensively covered by savanna grasslands interspersed with barren lands (badlands). These grassy areas can potentially be a major source of soil erosion. Also, the proposed footprints are generally located on various types of Akina soils, which are highly susceptible to erosion and can produce high concentrations of very fine clay suspended sediments.

Off-road activity appears to be extensive on the private lands, which may further aggravate soil erosion. Overall, the areas proposed for locating the six EW-Alignment Ranges are characterized by relatively high soil erosion potential.

3.4.2.3 Soil Geochemistry (Lead Mobilization Potential)

Soil pH and CEC values for the proposed EW-Alignment Range footprints are presented in **Table 8**. The average pH and CEC values for the firing range areas are 5.3 and 32.5 meq/100g, respectively, compared to an average pH and CEC values of 5.2 and 30.6 meq/100g, respectively for the dispersion areas. For this alignment as a whole, the higher CEC values imply an increased lead mobilization potential, which is partially mitigated by its higher pH.

Table 8: EW-Alignment – Soil Geochemistry Characterization for Lead Mobilization Potential

	Average pH units	Average CEC (meq/100g)
Firing Range Area		
HG	5.4	35.7
KD Rifle	5.4	33.9
MPMG	5.3	32.8
MRF	5.2	29.8
Pistol	5.0	28.0
Small Arms	5.5	33.3
EW-Alignment as a whole	5.3	32.5
Dispersion Area		
HG	5.5	35.4
KD Rifle	5.1	29.9
MPMG	5.1	30.1
MRF	5.2	31.1
Pistol	5.2	31.6
Small Arms	5.3	31.8
EW-Alignment as a whole	5.2	30.6

3.4.2.4 Fire susceptibility

Since the proposed footprints for the EW-Alignment are extensively covered by savanna grasslands, these areas can be considered to be highly susceptible to fire (**Figure 17**). In fact, these grasslands appear to have been established and maintained through an established cycle of burn-grow-burn. The likelihood of outside fire sweeping onto the proposed ranges is also high and poses an elevated risk to range property and operations.

Appropriate fire suppression and mitigation measures will have to be incorporated into the design (fire resistant structures) and range operating procedures. These measures will also have to include landscaping with fire-resistant vegetation that can become established in the depleted soils. Overall, the EW-Alignment appears to have the highest fire susceptibility compared to the other two alignments.

3.4.2.5 ESA Issues

The proposed EW alignment range footprints are mainly located on savanna grasslands interspersed with a few isolated wetlands, which could potentially be utilized by moorhens. Overall, approximately 80.4 ac of natural areas that can potentially be utilized by sensitive species such as the federally and Guam-endangered Mariana swiftlet and Mariana common moorhen (DoN 2010) are present within the actual footprint boundaries; additional habitat is likely present between the different ranges.

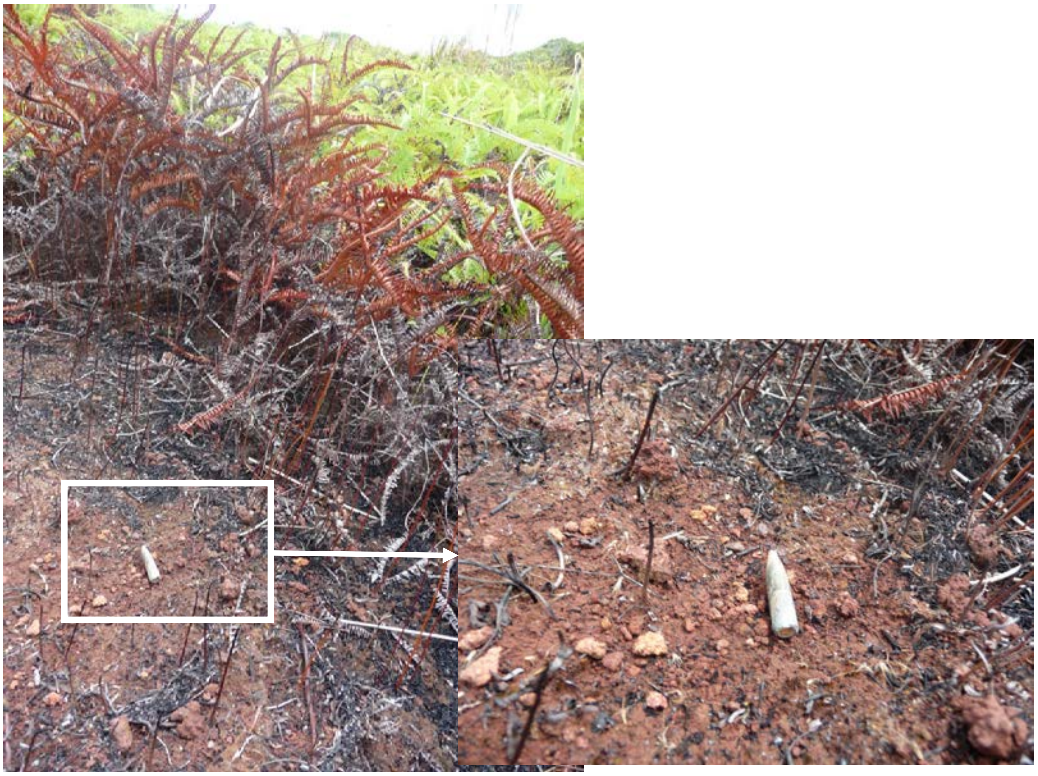

Figure 17: Recent Burn and Expended Rifle Round Near Proposed EW-Alignment KD Rifle Range Footprint

No suitable foraging habitat for the federally threatened and Guam-endangered Mariana fruit bat occurs in the areas proposed for locating the EW-Alignment Range footprints. Also, the proximity of the EW-Alignment range footprints to privately owned lands, and limited recent occurrence of the species in this area further limits the potential that fruit bats transit through this are during nightly movements to and from foraging areas. However, since suitable foraging habitat does occur in the surrounding areas, if the EW-Alignment is further evaluated, it is recommended that such evaluations include a baseline Mariana fruit bat survey to determine the current nature of fruit bat activity across the study area.

The Federal and Guam-endangered Mariana common moorhen is known to be present in the NMS (JRM 2011). Surveys conducted by Takano in the 2001 dry season determined that 38 of the 90 birds estimated to be present on Guam occurred in the NMS (Takano and Haig 2004). Thirty-three of these used the FVR as habitat. Moorhen numbers have declined at FVR since the loss of the introduced water plant hydrilla (*Hydrilla verticillata*) following a typhoon in 2001, and the current population and distribution in NMS is not well understood.

Since many of the proposed EW-Alignment Range footprints are located on private lands, these areas could not be assessed for presence of potential moorhen habitat during the site visit. However, there are no current records of moorhens occupying any of the wetland habitats that fall within these footprints (USFWS 1991). If the EW-Alignment is evaluated further, it is recommended that such evaluations include moorhen habitat suitability surveys within and adjacent to the proposed footprints to determine if further moorhen surveys are necessary.

Mariana swiftlets occupy three nesting caves that are located north of the proposed EW-Alignment Range footprints on the border between the NTW and the STW. These caves are situated well outside all of the proposed range footprints including their SDZ areas. The primary foraging area for these swiftlets generally extends east from the FVR spillway into the STW (Morton and Amidon 1996). It is possible that the birds may also use portions of the savannas and ravine forests within the proposed EW-Alignment footprints for foraging purposes. If the EW-Alignment is evaluated further, it is recommended that such evaluations include determination of the extent to which this area contributes to the overall foraging area for the Mariana swiftlet.

Five Guam-endangered lizards have the potential to occur in the NMS, Slevin’s skink, moth skink, Pacific slender-toed gecko, oceanic gecko, and Micronesian gecko. Of these five, the Slevin’s skink, which uses old fields and forest floor as habitat, has the greatest potential to occur within the vicinity of the proposed EW-Alignment Range footprints. Moth skinks, Pacific slender-toe geckos, oceanic geckos, and Micronesian geckos generally prefer more heavily wooded, rocky, or limestone forest habitats, but still may occur in the riparian forest areas adjacent to the proposed EW-Alignment footprints. If the EW-Alignment is evaluated further, it is recommended that such evaluations include surveys of savanna habitats and adjacent riparian forests to determine if Slevin’s skink or other Guam-endangered lizards are present in or around the footprint areas.

Crampton (1925) did not collect tree snails from the Talofofo River watershed, but Hopper and Smith (1992) documented presence of Federal candidate and Guam-endangered Guam tree snails and fragile tree snails from the lower Talofofo River watershed. Suitable habitat for tree snails would be restricted to the ravine forests adjacent to proposed EW-Alignment Range footprints. If the EW-Alignment is evaluated further, it is recommended that such evaluations include surveys of riparian forest habitats adjacent to range footprints to determine the presence of any of the three Federal candidate or Guam-endangered tree snail species, the Guam tree snail, humped tree snail, or fragile tree snail.

The larval-host plants for the Mariana eight-spot butterfly larvae (*Elatostema calcareum* and *Procris pedunculata*) primarily grow on limestone substrates. This type of substrate is not in or around the proposed EW-Alignment Range footprints, and therefore this species is not likely to occur in this area.

Hayun-lago has been recorded growing on limestone and volcanic soils in mature limestone forest and ravine forest. The federally endangered hauyn-lago is not known to occur in the EW-Alignment Range footprint area; however suitable habitat to support this species may be present within ravine forests adjacent to and between the range footprints. If the EW-Alignment is evaluated further, it is recommended that such evaluations include surveys of adjacent ravine forests for the presence of hayun-lago.

The Guam-endangered tsatsa has been previously documented in the ravine forest or muddy savanna drainages in the southern hills of Guam (DAWR 2006). This type of habitat is associated with the proposed EW-Alignment Range footprints and therefore the presence of this plant species cannot be ruled out. If the EW-Alignment is evaluated further, it is recommended that such evaluations include surveys of savanna and adjacent ravine forest areas for presence of tsatsa.

3.4.3 L-Alignment

3.4.3.1 Surface Hydrology and Flooding Potential

Similar to the EW-Alignment, the rivers Sagge, Sarasa, and Bubulao receive drainage from the L-Alignment range footprints (**Figure 7**). The area proposed for locating the L-Alignment HG Range is drained by the Sagge River and one of its unnamed tributaries to the east. The proposed Small Arms Range footprint is located immediately adjacent to the channel of this unnamed tributary, where it possibly encroaches into the active flow path. To the south, the MRF Range and the majority of the KD Rifle Range drain to Sarasa River.

The remaining fragments of the KD Rifle Range and the Pistol Range drain into the Bubulao River at the northern extent of the Ugum Watershed. The proposed footprint of the L-Alignment MPMG Range is located in the NTW and drains to the Talisay River.

The Sagge, Sarasa, and Bubulao rivers all have Zone A FEMA mapped floodplains (**Figure 14**). However, none extend to the upstream reaches adjacent to the range footprints. This indicates that no inundation limits or flooding risk has been assessed in these areas.

3.4.3.2 Erosion Potential

The southern five range footprints of the L-Alignment are characterized primarily by Akina soils (Ylig soils for the Small Arms Range), which are extremely erodible, especially on steep slopes, and are covered by savanna grasslands interspersed with badlands. Both these factors make these areas highly prone to soil erosion. The HG range footprint is located mainly within a single extensive badland.

3.4.3.3 Soil Geochemistry (Lead Mobilization Potential)

Soil pH and CEC values for the areas proposed for locating the proposed L-Alignment Ranges are presented in **Table 9**. The average pH and CEC values for the footprint areas are 5.8 and 30.9 meq/100g, respectively, compared to an average pH and CEC values of 5.2 and 29.4 meq/100g, respectively for the dispersion area. For the L-Alignment as whole, the firing range areas are characterized by higher average pH and CEC values, which implies both a greater and lesser capacity for lead migration.

3.4.3.4 Fire susceptibility

Overall, the areas proposed for locating the L-Alignment firing ranges are situated in grassy savannas interspersed by areas of ravine forest.

Table 9: L-Alignment – Soil Geochemistry Characterization for Lead Mobilization Potential

	Average pH	Average CEC (meq/100g)
Firing Range Area		
HG	5.4	35.7
KD Rifle	5.3	32.8
MPMG	6.6	26.9
MRF	5.3	31.5
Pistol	5.6	35.0
Small Arms	5.4	32.2
L-Alignment as a whole	5.8	30.9
Dispersion Area		
HG	5.3	32.7
KD Rifle	5.1	29.6
MPMG	5.5	28.2
MRF	5.2	30.8
Pistol	5.1	29.5
Small Arms	5.0	28.5
L-Alignment as a whole	5.2	29.4

This area is highly susceptible to fires. The MPMG Range located within NMS lowers the overall fire risk of the L-Alignment due to its location within a heavily forested area.

3.4.3.5 Fire susceptibility

Overall, the areas proposed for locating the L-Alignment firing ranges are situated in grassy savannas interspersed by areas of ravine forest. This area is highly susceptible to fires. The MPMG Range located within NMS lowers the overall fire risk of the L-Alignment due to its location within a heavily forested area.

3.4.3.6 ESA Issues

The areas proposed for locating the L-Alignment Range footprints include several different types of natural areas that may potentially be used by federal and Guam-endangered species such as the Mariana swiftlet and Mariana common moorhen (DoN 2010), and the federally threatened and Guam-endangered Mariana fruit bat. Overall, approximately 81.8 ac of such natural areas occur within the actual footprint boundaries; additional areas may also be present in between the footprints proposed for the different ranges.

The Mariana fruit bat is has the potential to occur in areas proposed for locating the L-Alignment Ranges. Rare observations have been reported recently (JRM 2011), but no large fruit bat colonies have been recorded in the NMS since census efforts began in 1962 (JRM 2011). If the L-Alignment is evaluated further, it is recommended that such evaluations include a baseline

Mariana fruit bat survey to determine the current population size and distribution within the study area.

The federally-endangered and Guam-endangered Mariana common moorhen is known to be present in the NMS (JRM 2011). Surveys conducted by Takano in the 2001 dry season determined that 38 of the 90 birds estimated to be present on Guam occurred in the NMS (Takano and Haig 2004). Thirty-three of these birds used the FVR as habitat. Moorhen numbers have declined at the FVR since the loss of the introduced water plant hydrilla (*Hydrilla verticillata*) following a typhoon in 2001, and the current population and distribution in NMS is not well understood.

Currently, there are no records of the Mariana common moorhen occupying wetland habitats associated with the L-Alignment footprints located to the east of the FVR or in the vicinity of the proposed MPMG Range northwest of the FVR. An undelineated open-water wetland is present at the south end of the proposed MPMG Range, which may provide suitable wetland habitat for the moorhens. Some of the marsh and swamp areas located in and around the proposed footprints to the east of the FVR may also be suitable moorhen habitat. If the L-Alignment is evaluated further, it is recommended that such evaluations include moorhen surveys in likely moorhen wetland habitats within and adjacent to the proposed footprints in order to better characterize the population and distribution of the moorhens.

Mariana swiftlets occupy three nesting caves north of the proposed EW-Alignment Range footprints, on the border between the NTW and the STW. These caves are well outside of all the proposed L-Alignment Range footprints including the SDZ areas. The primary foraging area for these swiftlets generally extends east from the FVR spillway into the STW (Morton and Amidon 1996). It is possible that the birds may also use portions of the savannas and ravine forests within the proposed L-Alignment footprints for foraging purposes. If the L-Alignment is evaluated further, it is recommended that such evaluations include determination of the extent to which this area contributes to the overall foraging area for the Mariana swiftlet.

Five Guam-endangered lizards have the potential to occur in the NMS, Slevin's skink, moth skink, Pacific slender-toed gecko, oceanic gecko, and Micronesian gecko. Of these four, the Slevin's skink, which uses old fields and forest floor as habitat, has the greatest potential to occur within the proposed L-Alignment Range footprints or their vicinity. Moth skinks, Pacific slender-toe geckos, oceanic geckos, and Micronesian geckos generally prefer more heavily wooded, rocky, or limestone forest habitats, but still may occur in the riparian forest areas located in and around the proposed MPMG Range footprint. If the L-Alignment is evaluated further, it is recommended that such evaluations include surveys of the riparian forest and savanna habitats to determine if Slevin's skink or other Guam-endangered lizards are present in or around the footprint areas.

Three species of native tree snails were recorded on Mt. Alifan in 1921 by Crampton (1925), including the humped tree snail, Guam tree snail, and Alifan tree snail (*Partula salifana*). The latter species was believed to be endemic to the central highland area around Mount Alifan, while the other two species are Federal candidate and Guam-endangered species. Surveys conducted by Hopper and Smith (1992) did not find live tree snails in the Mount Alifan area, and the Alifan tree snail is now considered extinct. The area proposed for locating the L-Alignment MPMG Range is in close proximity to Mount Alifan and is in fact part of the same limestone forest community. Therefore, there is potential for Federal candidate and Guam-endangered tree snails to occur in this area.

Crampton (1925) did not collect tree snails from the Talofofo River watershed, but Hopper and Smith (1992) documented the presence of Federal candidate and Guam-endangered Guam tree snails and fragile tree snails from the lower Talofofo River watershed. Suitable habitat for tree snails in the proposed L-Alignment Range footprints would be restricted primarily to the ravine forests habitat adjacent to range footprints. If the L-Alignment is evaluated further, it is recommended that such evaluations include surveys of adjacent riparian forest habitats to determine the presence of any of the three Federal candidate or Guam-endangered tree snail species—the Guam tree snail, humped tree snail, or fragile tree snail.

The Federal candidate Mariana eight-spot butterfly can be found in limestone forest habitats where their larval host plants, *Elatostema calcareum* and *Procris pedunculata,* are present. Adult butterflies may also occur in other habitat types adjacent to limestone forest containing larval host plants. Limestone forest is present in the area proposed for locating the L-Alignment MPMG Range footprint, and therefore it is possible that this butterfly species may occur in this area. Surveys are recommended to determine if the Mariana eight-spot butterfly host plant are present. If the host plants are present, additional surveys are recommended at host plant patches to determine if the host plant is occupied by Mariana eight-spot larvae or if adult butterflies are present in the area.

Hayun-lago has been recorded growing on limestone and volcanic soils in mature limestone forest and ravine forest. Both vegetation types occur in the areas proposed for locating the L-Alignment Ranges. Ufa-halomatano grows in limestone forest, often on cliff exposures. Limestone forests occur in the area proposed for locating the L-Alignment MPMG Range footprint. Tsatsa can be found growing in ravine forest or muddy savanna drainages in the southern hills of Guam (DAWR 2006). The ravine and savanna vegetation in the areas proposed for locating some of the L-Alignment footprints may support tsatsa. If the L-Alignment is evaluated further, it is recommended that such evaluations include vegetation surveys at least in the habitats identified above.

3.5 Property Ownership

Each of the three alignments includes varying proportions of Navy-, GovGuam-, and privately-owned lands (**Figure 3**, **Table 10**). The NS-Alignment SDZ footprint covers approximately 2,900 ac and more than 98 percent of this acreage is owned by Navy. Less than two percent is owned either by GovGuam or by private land owners. The EW-Alignment SDZ footprint covers approximately 3,166 ac and more than 50 percent of this acreage is owned either by GovGuam or by private land owners. The L-Alignment SDZ footprint covers approximately 3,862 ac and about 18 percent of this acreage is either GovGuam-owned or under private ownership.

Table 10: Property Ownership by Alignment

	Total SDZ Footprint Area (ac)	GovGuam/Private Acreage	% GovGuam/Private
NS-Alignment	2,900	48	<2%
EW-Alignment	3,166	1,668	53%
L-Alignment	3,862	697	18%

3.6 LFTRC Range Footprint Characterizations

Erosion, sediment-runoff, and flooding potential associated with each individual proposed range footprint will be influenced by factors such as existing terrain and drainage patterns, soils, and surface hydrology. Salient information on these parameters and a qualitative assessment of the potential for loss of natural habitats and offsite flooding associated with each proposed range footprint is summarized in **Table 11**. A more detailed discussion of these issues is presented in **Attachment B**.

Endangered, threatened, and candidate species likely to be present in and around the proposed LFTRC Range footprints are identified in **Table 12**.

Table 11: LFTRC Proposed Range Footprints – Characterizations of Existing Conditions

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
North-South	KD Rifle	• Talisay River flows through the footprint. • Multiple separate flow paths drain the proposed footprint through wetland areas to the Talisay River. • The change in land cover will need to be considered in designing onsite drainage facilities. • Flooding may impact range access and operations.	• Terrain gently sloping with possible line-of-sight issues. • Range type requires multiple firing berms. • Firing lines would need to be raised to solve line-of-sight and drainage issues. • The target line area would need to be lowered through excavation.	• Dominated by Akina silty clays, 7 to 15 percent slopes interspersed with Inarajan clay, 0 to 4 percent. • Minor components of Akina silty clays, 15 to 30 percent slopes and Ritidian rock outcrop 3 to 15 percent slopes.	• Short access road required for both ends of the range. The road at the firing end of the range should avoid low areas around the Talisay River. • Inarajan clays are usually not erosion prone, but since these soil units are located in and around active stream channels, development and disturbance within these soil units may lead to increased soil erosion. • The change in vegetative land cover following development could increase erosion potential.	• Footprint associated with approximately 9.41 ac of wetland acreage (Wetlands 56, 56A and 56B as identified by AECOS and Wil Chee 2009). • Wetland 56 is a swamp wetland containing pago, kafu and karriso (*Phragmites karka*). • Wetland 56A and 56B support a Fimbirstylis/ Dimeria vegetation community with scattered kafu, *Lygodium microphyllum* and *Acrostichum aureum*.	• Multiple separate flow paths drain the areas proposed for the footprints, sometimes through wetlands, into either the Talisay or the Bonya River. • None of the proposed footprints are located in FEMA-designated Special Flood Hazard Areas. • Soils are characterized by lower erosion potential. • Area is covered with dense vegetation, which further reduces the likelihood of soil erosion. • Soil disturbances resulting from ungulate activity appears to be one of the major potential sources of erosion. • Areas proposed for the footprints are characterized by slightly higher pH and CEC values, which means relatively lower lead mobilization potential compared to the dispersion areas. • Compared to the other two alignments, the NS-Alignment has the higher pH and lower CEC values. • Risk of fire spreading into the area from outside the range complex is low. • Substantial amount of grading is likely going to be needed, which means more
	HG	• Talisay River flows just to the north of the proposed footprint. • Footprint drains through wetland areas to the Talisay River. • The change in land cover will need to be considered in designing onsite drainage facilities. • Talisay River flooding may impact range access and operations.	• Located on terrain sloping to the Talisay River. • Cut and fill required to level site. Areas raised by fill will help reduce flood risk.	• Footprint split between Inarajan clay, 0 to 4 percent slopes and Akina silty clays 7 to 15 percent slopes.	• No additional roads will be needed, meaning less road construction and therefore reduced potential for construction activity-related soil erosion. • Inarajan clays are usually not erosion prone, but since these soil units are located in and around active stream channels, development and disturbance within these soil units may lead to increased soil erosion potential. • The change in vegetative land cover following development could increase erosion potential.	• No wetlands associated with this footprint; nearest wetland is Wetland 61.	
	Pistol	• Bonya River flows to the north of the proposed footprint. • Potential for receiving substantial offsite flow is low.	• Located at the site of an existing munition storage bunker. • Current area is fairly level. • Earthwork requirements will likely be driven by impact	• Dominated by Akina silty clays, 7 to 15 percent slopes	• The proposed footprint and access to this area would require no additional road construction. • The gradual slopes of the site, the minimal earthwork requirements, and easy	• No wetlands associated with this footprint; nearest wetland is Wetland 50.	

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
		• Flooding potential is low.	berm requirements and the desire to balance cut and fill.		access reduce the soil erosion potential throughout the life of the project.		earthwork and therefore increased potential for construction-activity-related soil erosion. • Relatively short secondary roads will be needed to access the proposed range, which means less road construction and therefore reduced potential for construction activity-related soil erosion. • Large amounts of earthwork also raise the risk of erosion during operational phase, because graded features (cut and fill slopes), shifted stream channels, and altered flow patterns can potentially create conditions which may facilitate additional soil erosion. • Land cover change would also increase the runoff volume, impact of raindrop erosion, potential for sheet and rill erosion.
	Small Arms	• Located within both the Talisay and Bonya contributing areas. • The change in land cover will need to be considered in designing onsite drainage facilities. • Potential for receiving substantial offsite flow is low. • Flooding potential is low.	• Located primarily on level ground, the range dips downslope to the south at the target end of the range. • Cut and fill needed for a flat range surface throughout the engagement area. • Three sided impact berm possible at this site.	• Dominated by Akina silty clays, 7 to 15 percent slopes.	• No additional roads will be needed, meaning less road construction and therefore reduced potential for construction activity-related soil erosion. • The gradual slopes of the site and easy access reduce the soil erosion potential throughout the life of the project. • The change in vegetative land cover following development could increase erosion potential.	• No wetlands associated with this footprint, nearest wetland is Wetland 50.	
	MRF	• Talisay River runs well north of footprint. • Multiple flow paths drain proposed footprint area through wetland areas to the Talisay River. • The change in land cover will need to be considered in designing onsite drainage facilities. • Site receives offsite flow from the higher terrain to the south. • An open-water pond is located at the north corner of the footprint. • Flooding potential is low.	• 50-60 foot elevation difference between firing line and the target end of the range. • Significant line-of-sight issues. • Significant cut and fill likely to be required resulting in large artificial slopes.	• Dominated by Akina silty clays, 7 to 15 percent slopes.	• Short access roads will be required at this site. • The substantial amount of earthwork required during construction, as well as the introduction of cut-and-fill slopes, increases the erosion concerns of this site. • The change in vegetative land cover following development could increase erosion potential.	• Footprint associated with approximately 3.23 ac of Wetland 56, which resembles a Fimbirstylis/ Dimeria community. Some *Acrostichum aureum* present.	

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
	MPMG	• Talisay River headwaters begin south of the range footprint and flow east. • Multiple flow paths drain footprint to Talisay River. • The change in land cover will need to be considered in designing onsite drainage facilities. • Site receives significant offsite flows. • Flooding potential is low in the operational range areas. • The impact berm and associated fill at the target end of the range has potential to encroach into the active channel of the Talisay River. • Undelineated open-water wetland located to the southwest of range footprint.	• Located along the side slope of a north to south oriented ridge. • Potential line-of-sight issues due to length of footprint. • Significant grading will be required to overcome line-of-sight issues and offsite drainage concerns.	• Dominated by Ritidian rock outcrop, 15 to 60 percent slopes. • Minor component of Akina-Atate association.	• Access roads for maintenance within the target area will be the longest in the NS Alignment. • Soil type is characterized by relatively low erosion potential. • The change in vegetative land cover following development could increase erosion potential. • Potential impacts to the Talisay River could encourage localized channel degradation.	• Footprint associated with approximately 0.19 ac Wetland 30, which is a sword grass-dominated wetland with small streams and seeps feeding the Talisay River.	

*Numbered wetlands refer to wetlands described in AECOS and Wil Chee 2009.

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
East-West	KD Rifle	• Site runoff drains to both the Sarasa and Sagge River systems. • Offsite flows originating from eroded badland areas enter the footprint at multiple locations. • Flooding potential is low.	• Cut-and-fill earthwork required at the target end of the range. • Range type requires multiple firing berms.	• Togcha-Akina silty clays, 3 to 7 percent slopes and Akina-Badland complex.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint.	• Buffer wetlands associated with the Sarasa River to the south are located in close proximity to the range footprint.	• Multiple flow paths drain the areas proposed for locating the ranges to the Tinechong, Sagge, Sarasa, or Malaja rivers. • None of the proposed footprints are located in FEMA-designated Special Flood Hazard Areas. • Since the proposed footprint is located outside the NMS boundaries and mostly on private lands, significant road construction will be needed to provide access to the range. • Soil erosion potential is high since most footprint areas are located on various types of Akina soils, which are highly susceptible to erosion and can produce high concentrations of very fine clay suspended sediment. • Most footprints are extensively covered by savanna grasslands interspersed with barren lands (badlands), both of which can potentially be a major source of soil erosion. • Areas proposed for the footprints are characterized by slightly higher pH and higher CEC values as compared to the dispersion areas. • Risk of fire is high since many of the proposed footprints are extensively covered by savanna grasslands. • A couple of proposed footprints will most likely
	HG	• Site runoff drains to an unnamed tributary of the Sagge River. • Offsite flows originating from eroded badland areas enter the footprint at multiple locations. • Flooding potential is low.	• Located along a steeply sloped finger. • Cut and fill required to level site. • Earthwork requirements will impact offsite and onsite drainage layout.	• Located predominately on Akina-Badlands complex with some Ylig clay, 3 to 7 percent slopes.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint. • Cut-and-fill slopes increase erosion potential.	• Buffer wetlands associated with a major unnamed tributary of the Sagge River to the north are located in close proximity to the range footprint.	
	Pistol	• Located upslope of the confluence of the Sarasa and Malaja Rivers. • Multiple flow paths drain the	• Likely to have minimal earthwork requirements and focused on impact berm development.	• Dominated by Akina Badlands complex. • Site appears to be developed previously for agricultural	• Access road construction required. • Akina soils are generally characterized by relatively	• Wetland areas associated with the Malaja River exist in close proximity to the range footprint.	

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
		footprint area to the Sarasa and Malaja Rivers. • Flooding may impact range access and operations. • Minor offsite flows originating from eroded badland areas enter the footprint from the west. • Flooding potential is low.		use.	high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint.		need substantial amount of grading, which means more earthwork and therefore increased potential for construction-activity-related soil erosion. • Large amounts of earthwork also raise the risk of erosion during operational phase, because graded features (cut and fill slopes), shifted stream channels, and altered flow patterns can potentially create conditions which may facilitate additional soil erosion.
	Small Arms	• Located entirely within the Ugum Watershed. • Footprint drains to the Bubulao River. • Offsite flows enter the range footprint from the north and west. • Located a short distance upslope of buffer wetland areas. • Flooding potential is low.	• Located mid-slope of terrain leading down to the Bubulao River. • Earthwork required due to existing cross slope and impact berm requirements. • Stabilized cut-and-fill slopes will be required.	• Dominated by Togcha-Akina silty clays, 3 to 7 percent slopes.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint.	• Wetland areas exist in close proximity to the range footprint.	
	MRF	• Multiple flow paths drain footprint through wetland areas to an unnamed tributary of the Sagge River. • Major stream flows through footprint. • Site receives minor offsite flows, primarily from the higher terrain to the north. • Flooding potential is low.	• Located on a combination of high points, hillsides, and ravines. • Some line-of-sight issues from the firing line. • Significant grading likely to be required to overcome line-of-sight issues, offsite drainage concerns, and to provide for reasonable target and firing locations.	• A combination of Togcha-Akina silty clays. 7 to 15 percent slopes, Akina badland complex, 7 to 15 percent slope and 15 to 30 percent slope.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of	• Buffer wetlands associated with a major unnamed tributary of the Sagge River to the north and south are located in close proximity to the range footprint.	

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
					savanna grassland and badland land types could improve erosion potential within the footprint. • Significant earthwork requirements and artificial cut/fill slopes increase the erosion potential.		
	MPMG	• Malaja River flows through footprint. • Multiple flow paths drain footprint through wetland areas to the Malaja and Sarasa River. • Flooding may impact range access, operation, and construction. • Robust drainage facilities will be required to deal with onsite and offsite flows.	• Substantial line-of-sight issues. • Significant grading likely to be required in the target engagement area to minimize line-of-sight conflicts. • Fill required at firing line to mitigate line-of-sight and flooding concerns.	• Dominated by Togcha-Akina silty clays, 3 to 7 percent. • Some areas have Ylig clay, 0 to 3 percent slopes and Akina badland complex, 7 to 15 percent slopes.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint. • Significant earthwork requirements and artificial cut/fill slopes increase the erosion potential.	• Range footprint contains 8.30 ac of buffer wetlands associated with the Malaja River.	

*Numbered wetlands refer to wetlands described in AECOS and Wil Chee 2009.

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
L-Alignment	KD Rifle	• Malaja River flows through footprint. • Multiple flow paths drain footprint through wetland areas to the Malaja and Sarasa River. • Flooding may impact range access, operation, and construction.	• Substantial line of sight issues. • Significant grading likely to be required in the target engagement area to minimize line of sight conflicts. • Firing lines would need to be raised to solve line of sight and drainage issues. • Fill required at firing line to mitigate line of sight and flooding concerns.	• Dominated by Togcha-Akina silty clays, 3 to 7 percent. • Some areas have Ylig clay, 0 to 3 percent slopes and Akina badland complex, 7 to 15 percent slopes.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint. • Significant earthwork requirements and artificial cut/fill slopes increase the erosion potential.	• Range footprint contains 2.69 ac of buffer wetlands associated with the Sarasa River.	• Multiple flow paths drain the areas proposed for the footprints to the Tinechong, Sagge, or the Bubulao Rivers. • Proposed range footprints are generally located high on the eastern slope of the FVR divide, where streams originate and are still relatively small. • None of the proposed footprints are located in FEMA-designated Special Flood Hazard Areas. • Since the proposed footprint is located outside the NMS boundaries and mostly on private lands, significant road construction will be needed to provide access to the range. • Many of the proposed footprint areas are characterized either by Akina soils, which are extremely erodible, especially on steep slopes, and/or covered by savannas grasslands interspersed with forested terrain and badlands. Soil erosion potential is relatively high. • Average soil pH and CEC values for the footprint area are higher than that for the dispersion areas indicating reduced lead mobilization potential. • High fire susceptibility.
	HG	• Drains a short distance downhill to an unnamed tributary of the Sagge River. • Likely located in the active channel of the tributary. • Offsite flow enters the range footprint from the south and east. • Extensive badlands upstream drain through the footprint. • Flooding potential is high.	• Located along the toe of a gentle slope. • Fill will be required to level the proposed range footprints in order to reduce flooding risk.	• Dominated by Ylig clay, 0 to 3 percent slopes • Some areas of Akina badland complex, 7 to 15 percent slopes.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint.	• Range footprint contains 0.38 ac of buffer wetlands associated with an unnamed tributary of the Sagge River.	
	Pistol	• Located in the Ugum watershed. • Footprint drains to the	• Located midslope, requiring earthwork to level range footprint and construct impact berm.	• Dominated by Togcha-Akina silty clays, 3 to 7 percent.	• Access road construction required. • Akina soils are generally	• No wetlands within or in close proximity of the proposed footprints.	

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
		Bubulao River. • Site receives offsite drainage from badland areas upslope. • Flooding potential is low.			characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint. • Earthwork requirements and artificial cut/fill slopes increase the erosion potential.		
	Small Arms	• Footprint drains to a tributary of the Sagge River. • Site receives offsite flow from extensive badland areas up slope. • Offsite drainage flows through an existing ravine running through range footprint. • Footprint extends into a buffer wetland around the unnamed tributary. • The site has potential to flood due to its proximity to the active channel.	• Earthwork will most likely be required to level the range surfaces. • Fill at the firing end of the range will reduce flooding risk, but will likely require increased encroachment into the adjacent wetland.	• Dominated by Togcha-Akina silty clays, 7 to 15 percent.	• Access road construction required. • Akina soils are generally characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint. • Significant earthwork requirements and artificial cut/fill slopes increase the erosion potential.	• Range footprint contains 0.21 ac of buffer wetlands associated with an unnamed tributary of the Sagge River.	
	MRF	• Multiple flow paths drain footprint to the Sarasa River.	• Range located on fairly flat terrain. • Earthwork driven by impact	• A combination of Togcha-Akina silty clays. 3 to 7 percent slopes and Akina badland complex, 7 to 15 percent slopes.	• Access road construction required. • Akina soils are generally	• No wetlands within or in close proximity of the proposed footprints.	

LFTRC Alignment	Range Type	Surface Hydrology and Flooding Potential	Terrain and Grading Requirements	Soils	Soil Erosion Potential	Wetlands*	Overall Comments
		• Offsite flows generated by extensive badlands enter the footprint from the west. • Flooding potential is low.	berm construction and line of sight concerns.		characterized by relatively high soil erosion potential. • Savanna grasslands can be a major source of soil erosion. • Soils highly susceptible to erosion, as evidenced by numerous badlands in the area. • Responsible development of savanna grassland and badland land types could improve erosion potential within the footprint. • Significant earthwork requirements and artificial cut/fill slopes increase the erosion potential.		
	MPMG	• Talisay River headwaters begin south of the range footprint and flows east. • Multiple flow paths drain footprint to Talisay River. • The change in land cover will need to be considered in designing onsite drainage facilities. • Site receives significant offsite flows. • Flooding potential is low in the operational range areas. • The impact berm and associated fill at the target end of the range has potential to encroach into the active channel of the Talisay River. • Undelineated open water wetland located to the southwest of range footprint.	• Located along the side slope of a north to south oriented ridge. • Potential line of sight issues due to length of footprint. • Significant grading will be required to overcome line of sight issues and offsite drainage concerns.	• Dominated by Ritidian rock outcrop, 15 to 60 percent slopes. • Minor component of Akina-Atate association, steep.	• Soil type is characterized by relatively low erosion potential. • The change in vegetative land cover following development could increase erosion potential. • Potential impacts to the Talisay River could encourage localized channel degradation.	• Footprint associated with approximately 0.32 ac Wetland 30, which is a sword grass-dominated wetland with small streams and seeps feeding the Talisay River.	

*Numbered wetlands refer to wetlands described in AECOS and Wil Chee 2009.

Table 12: Endangered, Threatened, and Candidate Species Likely To Be Present In and Around the Proposed LFTRC Range Footprints

Common Name	Scientific Name	Commonly Used Habitat	Federal			Guam		NS-Alignment			EW-Alignment			L-Alignment		
			Endangered	Threatened	Listing Candidate	Endangered	Threatened	Species currently known to occur in and around the proposed footprints	Species may use the footprint areas only for foraging	Species not known to be present but suitable habitat may be present in and around the proposed footprints	Species currently known to occur in and around the proposed footprints	Species may use the footprint areas only for foraging	Species not known to be present but suitable habitat may be present in and around the proposed footprints	Species currently known to occur in and around the proposed footprints	Species may use the footprint areas only for foraging	Species not known to be present but suitable habitat may be present in and around the proposed footprints
Mariana fruit bat	*Pteropus mariannus mariannus*	Limestone forests and ravine forests.		X		X		X			X			X		
Mariana crow	*Corvus kubaryi*	Limestone forests, ravine forests, and agricultural fields.	X			X		The Mariana crow is presumed to be extirpated from Guam. Nearest population is on the island of Rota in the CNMI.								
Guam Micronesian kingfisher	*Todiramphus [Halcyon] cinnamominus*	Limestone forests and ravine forests.	X			X		This species exist on the island only as a captive population in a conservation program; It is not expected to be present within the LFTRC study area.								
Guam rail	*Gallirallus owstoni*	Grasslands and scrub vegetation.	X			X		This species exist on the main island only as a captive population in a conservation program; a small population was released on Cocos Island after the rat eradication program. It is not expected to be present within the LFTRC study area.								
Mariana common moorhen	*Gallinula choloropus guami*	Freshwater marshes, swamps, reservoirs, ponds, placid rivers, man-made wetlands, fish ponds, rice paddies, taro patches, sewage treatment plants, brackish water wetlands.	X			X		X					X			X
Mariana swiftlet	*Aerodramus vanikorensis bartschi*	Nest in caves and use savannas and ravine forests for foraging.	X			X			X			X			X	
Moth skinks	*Lipinia noctua*	Limestone forests and ravine				X				X	X			X		

Common Name	Scientific Name	Commonly Used Habitat	Federal			Guam		NS-Alignment			EW-Alignment			L-Alignment		
			Endangered	Threatened	Listing Candidate	Endangered	Threatened	Species currently known to occur in and around the proposed footprints	Species may use the footprint areas only for foraging	Species not known to be present but suitable habitat may be present in and around the proposed footprints	Species currently known to occur in and around the proposed footprints	Species may use the footprint areas only for foraging	Species not known to be present but suitable habitat may be present in and around the proposed footprints	Species currently known to occur in and around the proposed footprints	Species may use the footprint areas only for foraging	Species not known to be present but suitable habitat may be present in and around the proposed footprints
		forests.														
Pacific slender-toed geckos	*Nactus pelagicus*	Limestone forests and ravine forests.				X				X	X			X		
Slevin's skink	*Emoia slevini*	Limestone forests, ravine forests, and agricultural fields.				X				X	X			X		
Oceanic gecko	*Gehyra oceanica*	Limestone forests, ravine forests, Tangantangan forest, urban areas				X				X			X			X
Micronesian gecko	*Perochirus ateles*	Limestone forests.				X				X			X			X
Guam tree snail	*Partula radiolata*	Limestone forests and ravine forests.			X	X		X					X			X
Humped tree snail,	*Partula gibba*	Limestone forests and ravine forests.			X	X				X			X			X
Fragile tree snail	*Samoana fragilis*	Limestone forests and ravine forests.			X	X				X			X			X
Mariana eight spot butterfly	*Hypolimnas octocula marianensis*	Limestone forests.			X					X						X
Hayun-lago	*Serianthes nelsonii*	Limestone forests and ravine forests.	X			X				X			X			X
Tsatsa	*Cyathea lunluata*	Savanna and ravine forest slopes.				X				X			X			X

Common Name	Scientific Name	Commonly Used Habitat	Federal			Guam		NS-Alignment			EW-Alignment			L-Alignment		
			Endangered	**Threatened**	**Listing Candidate**	**Endangered**	**Threatened**	**Species currently known to occur in and around the proposed footprints**	**Species may use the footprint areas only for foraging**	**Species not known to be present but suitable habitat may be present in and around the proposed footprints**	**Species currently known to occur in and around the proposed footprints**	**Species may use the footprint areas only for foraging**	**Species not known to be present but suitable habitat may be present in and around the proposed footprints**	**Species currently known to occur in and around the proposed footprints**	**Species may use the footprint areas only for foraging**	**Species not known to be present but suitable habitat may be present in and around the proposed footprints**
Ufa-halomtano	*Heritiera longipetolata*	Limestone forests.				X				X						X

4.0 BMP AND LID RECOMMENDATIONS

This section contains recommendations for BMPs and LID practices that can be considered for implementation at the proposed firing ranges to reduce or eliminate the potential for adverse impacts. For the LFTRC, potential adverse impacts are associated with siting, construction, and/or operations of the individual firing ranges. Potential adverse impacts may arise due to soil erosion, discharge of untreated sediment- and munitions constituent-laden stormwater runoff and offsite flooding.

Potential siting impacts may occur due to encroachment of the proposed range footprints on sensitive habitats such as wetlands and stream channels or on soils with naturally high erosion susceptibility. Siting impacts may lead to loss of natural habitat and biological functions and increased soil erosion potential. Siting-related impacts can be substantially reduced by refining/relocating the proposed range footprints. Preliminary recommendations for refining/relocating some of the proposed range footprints are discussed in **Section 4.1**.

The DoD follows DoD Directive 4715.11 for construction, sustainable use, and management of operational ranges. Spent munitions remains on ranges through application of best management practices and adherence to DoD Directive 4715.11.Erosion control and sediment runoff management strategies that can be considered for implementation during the construction phase are discussed in **Section 4.2**. Operation phase strategies are described in **Section 4.3**. Site-specific BMPs that can be considered for implementation at the proposed ranges are identified in **Section 4.4**.

4.1 Construction-Phase Erosion and Sediment Runoff Control Strategies

Construction-phase impacts that may potentially cause or exacerbate naturally occurring soil erosion and sediment runoff are primarily related to construction of the range facility, supporting infrastructure (parking lots, administrative building), and access roads. Construction activities of concern include clearing of vegetation, grading (cut and fill), permanent or temporary accumulation of soils, stream rerouting, and filling in of natural areas. These activities are likely to result in increased soil erosion and sediment runoff potential.

Note that construction-related earth-moving activities, pollutant discharge, and final site stabilization will most likely be covered under a Guam EPA National Pollutant Discharge Elimination System General Permit for Discharges from Construction Activities (Construction General Permit [CGP]) and will also be subject to local Guam Erosion and Sediment Control Regulations (GSESCR) (Chapter 10 of Title 22 of the Guam Administrative Rules and Regulations). Key erosion control and sediment runoff management strategies that can be considered for implementation during the construction phase are discussed below[6]:

[6]Additional guidance on recommended BMPs to minimize erosion and sediment runoff is contained in the CGP and the GSESCR.

4.1.1 Timing

It is recommended that, to the extent possible, construction activities, especially ones that involve substantial earth moving, be scheduled for the dry season (January to May). While it does rain in Guam during the dry season, the rains are usually not as frequent or intense and the sediment-laden flows from construction areas can therefore be relatively easily managed. As a general rule, moving and relocating dry soils is easier than working with wet and saturated soils.

4.1.2 Vegetation

Once an area has been graded to its final configuration vegetation should be planted immediately to provide natural erosion control. The type of vegetation planted will largely depend upon the proposed use of a given area. For example, the area between the firing line and the targets will often require a clear line of sight and therefore will have to be planted with either short grass that will be periodically mowed or low native shrubs. Low, native scrub plants generally retain the soil better, have a lower risk of fire, and require less maintenance. Other areas located in and around the parking lots, staging areas, and range boundaries can be covered with trees and/or larger shrubs. Native vegetation should preferably be used for landscaping.

Appropriately suitable vegetation should also be considered for operational areas such as firing points, impact berm tops and sides, parking lots, and access roads. Berm sides and tops may not be ideal places for substantial vegetation, as lead removal activities will require frequent excavations. Roads and staging areas that are either partially paved or covered with gravel can also be partially vegetated to reduce erosion.

The type and amount of vegetation that can be planted at a firing range will also be influenced by the type of range. A Small Arms Range, for example, is designed to support many different shooting lines and target locations for a variety of close-range rifle and pistol employments, which will limit the amount of vegetation that can be planted on this range. Similarly, a HG Range also cannot be covered with dense vegetation as this would limit the ability to easily retrieve dud grenades.

Some areas are likely to require soil amendments to achieve conditions that are conducive for planting vegetation. For example, some of the ranges, as currently proposed, will have to be excavated 10 to 30 feet deep in some areas. If harsh weathered volcanic rocks are exposed by the excavation, they usually do not support vegetation without some type of soil amendments (fertilizer, mulch) being applied. Likewise badlands within the proposed footprints will have to be pretreated with soil amendments.

4.1.3 Stream Channels

Working in and around streams with flowing water requires special consideration since the eroded and/or disturbed sediments do not have to travel too far to enter the regional drainage system. In many of the smaller streams, the dry season will characteristically have lower flows or possibly none at all, and therefore it is recommended that work around stream channels be prioritized for the peak of the dry season. As necessary, flows may have to re-directed or pumped around the worksite.

If permanent relocation of channels or construction of bridges or culverts is required, these activities are also best completed before the start of the rainy season. Altered stream banks would also have to be finished, protected, and re-vegetated before the start of the rainy season. Note that relocating and/or rerouting natural drainage channels usually requires significant permitting effort, which may include U.S. Army Corps of Engineers (USACE) Section 404/401 permits.

4.1.4 Road Networks

Many of the proposed ranges associated with the EW and L-Alignments, in particular, are located in remote areas and are likely to require substantial road construction through mainly vegetated areas. The removal of the natural vegetative cover exposes the soils to the direct physical impact of the rain drops, causing them to become loose and easily mobilized by rapidly flowing stormwater. Also, if during and after road construction is completed the exposed areas are not appropriately and quickly stabilized, they become a perennial source of eroded sediments.

This source of sediments can be effectively controlled through the implementation and subsequent regular monitoring of site-specific BMPs, such as minimizing removal of natural vegetative cover, using mulch or erosion control blankets to cover exposed soils during construction, use of stormwater detention areas, or other engineered options to capture and treat stormwater runoff from areas under construction, as well as immediate reestablishment of a vegetative cover after construction is completed.

Overall, the areas proposed for locating the NS-Alignment Ranges are situated closer to existing infrastructure and are likely to require less access-road construction. The L-Alignment Ranges are located in relatively remote areas and will most likely require the largest amount of access-road construction. Note that road construction work that occurs on non-DOD lands will be subject to the requirements of the Guam Transportation Drainage Manual, published by the Guam Department of Public Works (GDPW 2010).

4.2 Operational-Phase Erosion and Sediment Runoff Control Strategies

During the operational phase, elements that may directly cause or exacerbate naturally occurring soil erosion and sediment runoff from a firing range include on-going soil disturbances resulting from vehicular and pedestrian traffic; inadequate maintenance of vegetated areas; increased stormwater runoff volume and velocity; contamination of stormwater runoff due to eroded sediments, lead, and other munitions constituents; and discharge of untreated contaminated stormwater runoff into critical or sensitive habitats including the FVR. An indirect impact of firing range operations may result from forest fires that may be caused due to the use of live ammunition. Fires tend to destroy the natural vegetative cover and expose the underlying soils to precipitation and runoff.

Increased volume of stormwater runoff from the range(s) may also contribute to offsite flooding. The runoff from operational areas is also the primary mechanism for offsite transport of eroded sediments and potentially harmful munitions constituents including lead. Firing range operational-phase BMPs should therefore primarily focus on reducing volume and velocity of stormwater runoff, minimizing soil erosion potential within the range boundaries and controlling the spread of lead bullets and bullet fragments.

Additional guidance on erosion and sediment runoff control strategies that can be considered during the operational phase is contained in the CNMI and Guam Stormwater Management Manual (Horsley Witten Group, Inc. 2005). Key erosion control and sediment runoff management strategies that can be considered for implementation during the operational phase are discussed below.

4.2.1 Stormwater Runoff Volume and Velocity Minimization

Stormwater runoff volume and velocity from a firing range can be effectively managed through the simultaneous implementation of the following three strategies:

- **Flow separation –** Offsite (off-range) flows should be completely segregated from onsite flows in order to minimize the amount of potentially contaminated stormwater that has to be managed. This can be achieved by either locating the range in an area where the existing topography permits easy flow segregation or by using engineered options to channel offsite flows away from active range surfaces into existing surface water conveyances (drainage ditches and streams) or into the landscape. Flows would be responsibly reintroduced to natural drainages or slopes in order to minimize downstream flooding or erosion. Techniques such as use of vegetated channels, level spreaders, and use of energy dissipation practices should be considered to reduce potential adverse impacts on downstream flows.

- **Ground covers –** Planting vegetative ground cover (such as grass) is an important and easy erosion control method. The presence of a vegetative ground cover significantly reduces the amount of sediments and lead that will run off the land surface during heavy rainfall events. Ground cover also promotes absorption of rainwater, which reduces the amount of water the lead is in contact with, as well as the time that the lead is in contact with the water. Furthermore, the ground cover will divert and slow down surface water runoff, thus helping to prevent sediments and lead from migrating offsite. A dense ground cover generally yields the greatest benefit at rifle and pistol ranges, where the bullet impact areas are sloped and water runoff and soil erosion may be more likely.

  An effective approach is to use grass to direct surface water drainage away from the target area (for example, planting at the top of the backstop or sand trap). This will minimize the water's contact with lead bullet fragments thereby minimizing the potential for lead migration. Note that grass is not impermeable. However, it does slow down the rate of flow and reduce the amount of lead entering the soil via rainwater. Grassed swales or bioretention areas can also be used to convey runoff to pre-determined places or capture runoff for onsite retention.

  Grasses and vegetation that attract birds and other wildlife are not recommended in order to prevent potential ingestion of lead by wildlife. Also grassy areas require periodic maintenance (mowing) for aesthetic reasons and to maintain their effectiveness.

Instead of vegetation, mulch and compost can also be considered for providing ground cover that will reduce the amount of water that comes in contact with the lead fragments. In addition, mulches and compost contain humic acid, which is a natural lead-chelating agent that actually sorbs lead out of solutions and reduces its mobility.

Like vegetative covers, organic surface covers like mulch and compost are not impermeable. In addition, the organic material needs periodic replacement to maintain effectiveness and aesthetic integrity. Furthermore, these materials should be removed prior to any lead removal event, as they may impede sifting or screening. Note that these materials tend to be acidic (especially during decomposition). So if low pH is a concern at a particular site, this option may not be appropriate. Lime applications may be considered to increase pH.

Note that grasses and ground covers should be carefully chosen to ensure high survivability given the soil types and conditions at the selected sites. Volunteer grasses are very likely to populate a landscaped area, especially if the planted grass does not take well to the location. Also ground cover needs to be carefully selected so it does not become an invasive problem. Mulch would be a high-maintenance option since it would require care and replacement. It would catch grass and other herbaceous plant seeds and rapidly become overgrown by volunteer plants. Also, if not properly managed, use of compost near natural flowpaths may lead to unintended water-quality problems.

- **Engineered controls –** The use of engineered controls to manage stormwater runoff volume and velocity is highly recommended in areas that receive heavy rainfall, such as Guam. Such controls are also very effective at firing ranges that are located either on rolling or sloped terrains (where the topography naturally accelerates stormwater runoff velocity) or in close proximity to surface-water bodies. Examples of engineered controls include: filter beds, containment traps and detention ponds, dams and dikes, and ground contouring.

  Filter beds are engineering controls built into an outdoor range to collect and filter surface-water runoff from the target range. The collected runoff water is routed to a filtering system, which screens out larger lead particles, raises the pH of the water (thus reducing the potential for further lead dissolution), and drains the water from the range area. This technique may not completely prevent lead from entering the subsurface, since lead bullets, fragments, and large particles may still remain on the range. At a firing range, filter beds are most effective at the base of the backstop. By design, the backstops and berms direct the runoff so that it drains from the range to the filters. The collected water then soaks through the top sand layer into the neutralization material. The filters typically consist of two layers: a fine-grained sand bed underlain by limestone gravel or other neutralization material.

  Containment traps and detention ponds are designed to settle out eroded sediments and lead particles during heavy runoff events. Use of vegetated swales to direct the flows into the traps further increases their efficiency. Strategically placed and appropriately oriented dams and/or dikes may also be considered to reduce velocity of surface water runoff. Such obstructions are usually oriented perpendicular to the direction of runoff to slow down the flow.

Ground contouring is another mechanism that can be used to slow runoff and prevent eroded sediments lead from being transported offsite. This typically involves altering drainage patterns to allow the runoff to slow down enough to permit suspended particles to settle out. Ground contouring may also be used to promote increased infiltration of the precipitation into the soil. Ground contouring may include practices such as terracing.

4.2.2 Soil Erosion and Sediment Runoff Potential Minimization

Soil erosion and sediment runoff from a firing range can be effectively managed by locating the range on soils with low erosion potential, minimizing the extent of denuded/exposed areas through the use of natural (vegetation) or artificial (mulch and compost) covers, and using engineered controls to contain eroded sediments before they leave the range.

4.2.3 Spent Munitions (Lead) Containment

The single most effective BMP for managing lead at a firing range is by containing and limiting the spread of the spent munitions. This can be achieved through the use of containment systems, which trap and hold the spent munitions until they can be recovered for offsite disposal. Commonly used spent-munitions containment systems include earthen berms and backstops, sand traps, steel traps, lamella or rubber granule traps, and shock-absorbing concrete. Each type of system can be customized for use at a given range to enhance its effectiveness.

4.3 Recommended BMPs

A fairly comprehensive list of applicable BMPs was presented in Volume II of the Guam and CNMI Relocation Final Environmental Impact Statement (DoN 2010). Additional relevant guidance is contained in the Guam/CNMI Stormwater Management Manual (Horsley Witten Group, Inc. 2006) and the Army Small Arms Training Range Environmental Best Management Practices Manual developed by the Aberdeen Test Center (DoA) 2005). Specific guidance on BMPs for minimizing lead migration from firing ranges is provided by the US Army Environmental Center (DoA 2005).

An example KD Rifle Range layout with recommended BMP locations is shown in **Figure 18**. BMPs that can specifically be considered for implementation at the LFTRC firing ranges are summarized in **Table 13**.

4.4 Monitoring BMP Effectiveness

During both the construction and operational phases, it is very important that effectiveness of implemented BMP(s) is monitored over time and that the results are used to guide performance improvement through an adaptive management program. BMP effectiveness monitoring is also a requirement under federal and local stormwater regulatory requirements. BMP effectiveness can be monitored through regular inspections of all implemented BMPs and water quality monitoring.

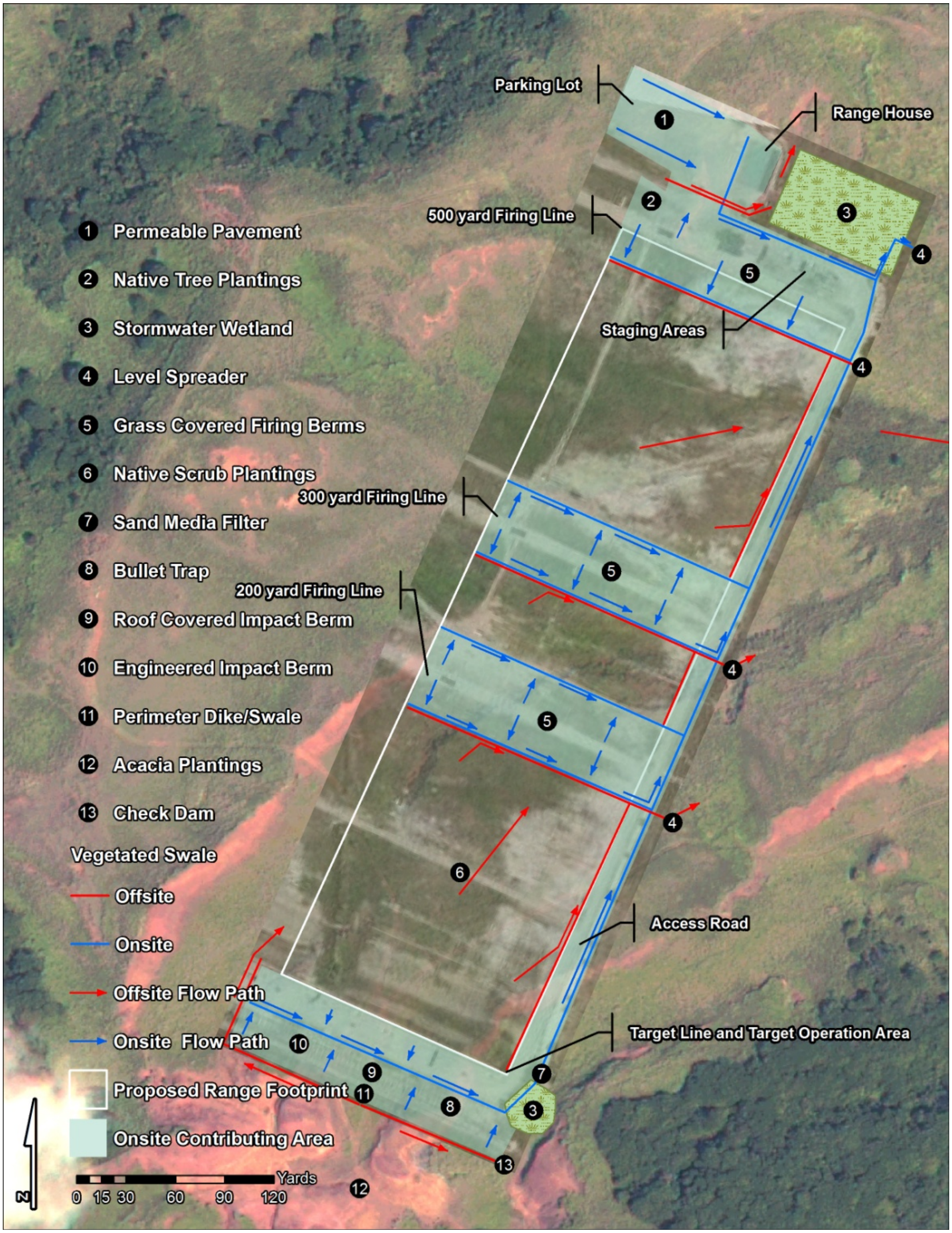

Figure 18: Operational BMP Conceptual Layout

(Conceptual range layout is based on one of the Marine Corps Base Camp Pendleton, California KD Rifle Ranges)

Table 13: Best Management Practice Descriptions

Category	BMP	Construction	Operation	BMP Description	LFTRC Application
Source: Guam and CNMI Military Relocation FEIS					
Erosion Control	Silt Fence	X		A barrier of geotextile fabric installed on the contours across a slope used to intercept sediment-laden runoff from small drainage areas of disturbed soil to reduce runoff velocity and effect deposition of transported sediment load.	The soils in southern Guam are eroded relatively easily, and once mobilized, the fine clay/silt particles are hard to capture. Also, extensive earthwork that is likely to be required for all proposed ranges will probably strip natural vegetative cover from large areas thereby making the soils more erosion prone. Implementation of erosion control techniques such as silt fences, fiber rolls, and erosion control blankets in areas with high erosion potential will substantially reduce the amount of sediments that are eroded and mobilized.
	Fiber Rolls	X		Tight tubular rolls constructed of wood excelsior, rice or wheat straw, or coconut fibers placed at regular intervals on the face of slopes and/or at the toe of the slope to intercept runoff, reduce its flow velocity, provide some removal of sediment from the runoff, and release the runoff as sheet flow. Fiber rolls can also be used for inlet protection and check dams under certain conditions.	
	Erosion Control Blankets	X		Erosion control blankets (geotextiles) are porous fabrics (filter fabrics, road rugs, synthetic fabrics, construction fabrics, or simply fabrics) placed to minimize or prevent erosion on exposed soils.	
	Stabilization (Vegetation, Sod, Mulch, or Topsoil)		X	Providing erosion control protection to a critical area for an interim period or establishing grasses with other forbs and/or shrubs to provide perennial vegetative cover on disturbed, denuded, slopes subject to erosion to provide temporary and/or permanent erosion and sediment control.	Many of the soil units found within the proposed range footprints are highly susceptible to erosion. During construction cleared or disturbed land should be immediately stabilized either with planted vegetation or with an organic cover (mulch or compost). Use of native plants and shrubs is highly recommended; grasses should be avoided, where practicable. Areas that do not directly affect range operations can be reforested. Operational areas such as firing berms may only be able to support low grass due to line-of-sight concerns. Some locations in the target areas might sustain a mixture of taller grasses and scrub.
	Check Dam		X	Small barriers or dams constructed of stone, bagged sand or gravel, or other durable material across a drainage way. The purpose is to reduce erosion in a drainage channel by restricting the velocity of flow in the channel.	Range construction is likely to result in substantial alterations in existing stormwater flow paths and runoff volume and velocity because of the extensive grading that will most likely be needed. Strategically located check dams are an effective tool for lowering runoff flow velocities and thereby reducing erosion damage within the drainage channels. Vetiver grass hedgerows may provide an effective, green, maintenance-free solution.
	Sediment Basin	X	X	A barrier or dam constructed across a drainage way or at other suitable locations to intercept sediment-laden runoff and to trap and retain the sediment to protect drainage ways, properties, and rights-of-way below the sediment trap from sedimentation.	Use of strategically located and appropriately sized engineered solutions such as sediment basins and sediment traps is highly recommended for the implementation during the construction phase. These BMPs are generally very effective at trapping larger soil particles. During the operational phase, the eroded sediments are more likely to consist of much finer particles that cannot be easily captured by sediment basins and traps.
	Sediment Trap	X	X	A sediment control device formed by excavation and/or embankment to intercept sediment-laden runoff and retain the sediment in order to protect drainage ways, properties, and rights-of-way below the sediment trap from sedimentation.	
	Rock Outlet Protection	X	X	A section of rock protection placed at the outlet end of the culverts, conduits, or channels to reduce the depth, velocity, and energy of water, such that the flow will not erode the receiving downstream reach.	Segregating offsite and onsite flows is highly recommended to reduce the volume of stormwater runoff that may potentially come in contact with the spent munitions. New or altered drainage channels will have to be constructed to route the offsite flows around the range boundaries and direct the onsite flows to onsite treatment areas. Implementation of outlet protection BMPs is highly recommended at the ends of the new or altered culverts, conduits, or channels to reduce the depth, velocity, and energy of water to ensure that the flows do not erode downstream reaches of the receiving water body.
	Level Spreader		X	A non-erosive outlet for concentrated runoff constructed to disperse flow uniformly across a slope. The purpose is to convert concentrated flow to sheet flow and release it uniformly over a stabilized area.	This BMP can be considered for implementation at the outfall(s) of constructed treatment wetlands (often referred to stormwater treatment areas or STAs), which are specifically designed to trap sediments and munitions constituents mobilized by onsite runoff, where such flows are being introduced into a wetland area or ravine with no defined stream channel.
Drainage	LID		X	LID is a design technology that makes use of innovative methods to capture stormwater that would otherwise flow into nearby watersheds using a combination of retention devices and vegetation to allow stormwater to be retained and managed at the source, rather than relying on downstream efforts to control the flow of water and contaminants. The objective is to improve the quality of receiving waters and stabilize flow rates of nearby streams by reducing water pollution and increasing groundwater infiltration.	LID techniques are strongly recommended for consideration at the LFTRC complex. Such concepts are generally integrated into the final facility design. Essentially use of these concepts decreases the volume of stormwater runoff that is discharged from the range. Examples of LID techniques that could be considered for implementation at the proposed LFTRC include use of bioretention swales, rain gardens, tree planter drains, cisterns at building sites, green roofs on buildings, and pervious pavements.
	Vegetated and Lined Waterways		X	A natural or man-made channel of parabolic or trapezoidal cross-section that is below adjacent ground level and is stabilized by suitable vegetation or concrete, stone, or other permanent material to intercept and convey runoff to stable outlets at non-erosive velocities.	At the LFTRC, vegetated swales can be considered for directing runoff from operational areas of a range (impact berms, firing lines, parking and staging areas, etc.) to designated collection/treatment areas. Swales should be designed to incorporate vegetation that is most appropriate for controlling fine sediments.

Category	BMP	Construction	Operation	BMP Description	LFTRC Application
	Perimeter Dike/ Swales	X	X	A temporary ridge of soil excavated from an adjoining swale located along the perimeter of the site or disturbed area built to prevent offsite storm runoff from entering a disturbed area and to prevent sediment laden storm runoff from leaving the construction site or disturbed area.	Perimeter swales are highly recommended for diverting offsite flows away (and usually around) the proposed range complex to existing surface water drainage channels. This reduces the volume of stormwater that comes in contact with onsite surfaces that are erosion prone (impact berms, cut slopes, etc.) or contain munitions constituents.
	Stormwater Ponds (Retention/ Detention)		X	Practices that have a combination of permanent pool and extended detention capable of treating the water quality volume treatment.	Strategically located and appropriately sized retention/detention ponds and constructed (treatment) wetlands are very effective in (1) reducing peak flows leaving the range and (2) trapping sediments and munitions constituents including lead. Through detention, downstream peak flows are reduced. This reduction in peak flow reduces peak velocities and the potential for downstream channel erosion potential. Use of stormwater treatment areas (constructed treatment wetlands) is a proven technique for reducing suspended (fine) sediment load. These features also provide valuable habitat of native wildlife. At the proposed LFTRC, small wetland-fringed ponds could be sited inline with the drainage system directly adjacent to impact berms. Such wetlands can also be customized to trap and treat solid and dissolved lead. This additional treatment can be achieved, for example, by directing the discharge from these wetlands into sand filters that are equipped with reactive media, which facilitates lead removal.
	Stormwater Wetlands		X	Practices that include significant shallow marsh areas, and may also incorporate small permanent pools or extended detention storage to achieve the full water quality volume treatment.	
Source: US Army Small Arms Training Range Environmental					
Lead Migration Control	Soil Amendments		X	Lime soil amendments help neutralize the pH of acidic soils and theoretically reduce lead corrosion. Solid state lead is less likely to migrate to downstream via surface or ground water. Primarily applicable where primary impact points lie primarily in berms or immediate vicinity of targets (KD Ranges with berms, etc.)	Many of the areas proposed for locating the ranges have slightly acidic pH, which increases the potential for lead mobilization. Use of soil amendments can be considered at such locations. The amendments can be used in containment berms and are generally most effect in the KD Rifle, Pistol, and possibly Small Arms Ranges. The MPMG and MRF Ranges could benefit from such treatments only if the berms are located immediately behind each target array.
	Bullet Traps		X	Bullet traps can provide total lead capture and containment when appropriately used. KD and other ranges with a well-defined shot pattern can effectively utilize bullet traps. Different trap types support different ammunition types. Operational and maintenance costs would be regular.	Bullet containment systems can be considered for implementation at the KD Rifle, Small Arms, or Pistol Ranges. Some of the proposed Pistol Range sites, for example, are located very close to surface water bodies and the risk of lead migration is much higher due to the short distance. Use of strategically located bullet trap(s) can substantially decrease the risk of ammunition directly landing into streams and channels.
	Lead Removal Activities		X	Periodic lead removal. Can be completed anywhere lead rounds come to rest, but areas of concentration (impact berms) are much more cost effective. Most methods still leave fine lead particles behind. Very expensive and time consuming.	This BMP is most applicable to KD Rifle, Small Arms, and Pistol Ranges. It may also be considered for other ranges if concentrated impact areas are integrated into the design or are created through the use of local impact berms. Note that the predominant soil type within the proposed range footprints is clay and silt, both of which are not very conducive to lead-removal activities.
	Impact Berm Design		X	Stable impact berms will provide projectile containment and be less susceptible to sheet and rill erosion. Maintenance is required to prevent bullet pockets from concentrated impacts and increasing the risk of erosion.	Stable and well-maintained impact berms (slopes) could be incorporated into every range type being considered for the LFTRC. Soil amendments could be mixed throughout the berm to optimize the soil pH and thereby reduce lead mobilization. Sandy soils could be imported from offsite locations to facilitate lead-removal activities. All faces of an impact berm should be vegetated. The backside of the berms could be planted with woody native vegetation, which is more apt to hold soil; the top and front are generally covered with grass to allow for periodic maintenance and lead removal.
	Sand Filters		X	BMP for the removal of suspended solids from small drainage areas (< 10 ac). The addition of reactive media to the sand filter may also effectively remove dissolved lead from stormwater runoff.	Use of reactive media-equipped sand filters is a very effective BMP for reducing suspended and dissolved lead concentrations in stormwater runoff. Such filters also work well when used in conjunction with treatment wetlands (pre- or post-treatment). The wetland traps suspended lead and coarse sediments; the filter then only have to deal with dissolved materials.
	Target Types		X	Target media can impact ricochet probability and SDZ size.	Only the MPMG and MRF Ranges are likely to utilize targets capable of creating ricochets. All others would utilize plastic or paper targets that are easily penetrated. MPMG Ranges could utilize steel vehicle hulks, tire stacks, steel person-shaped pop-ups, or even concrete bunkers. Use of steel targets generally produces ricochets and bullet fragmentation. Careful selection and design of targets would concentrate the distribution of projectiles and provide for a more controlled range environment.
Pollution Prevention	Green ammunition		X	Utilize ammunition that does not contain non-toxic metals in lieu of the traditional lead core.	The US Army is currently transitioning to the new M855A1 cartridge for their service rifles. This 5.56 mm round utilizes a copper core instead of the lead core of the M855. The Marine Corps recently fielded the new SOST round, which uses a lead core. A future transition to the M855A1 or similar lead-free round could eliminate further lead contamination at ranges that support 5.56 mm rounds, particularly at the KD Rifle, Small Arms, and MRF Ranges.

5.0 OBSERVATIONS AND DISCUSSION

Three alternative alignments for locating a potential LFTRC in south-central Guam are currently being evaluated by the Navy in an SEIS. Six types of firing ranges are being considered under each alignment. All alignments may potentially be located near rivers or streams and therefore the likelihood of adverse downstream impacts has to be considered during the selection of a preferred alignment. The LFTRC study area included the southern half of the NMS and the entire drainage basin of the FVR.

The purpose of the LFTRC Watershed Reconnaissance Study was to gather and evaluate data for the characterization of existing conditions in downstream riparian areas and identify locations that contribute significant amount of runoff and are prone to erosion and or flooding. The data were used to recommend BMP and LID measures that can be strategically applied at selected locations within the study area to reduce or eliminate potential for adverse impacts associated with soil erosion, discharge of untreated sediment- and munitions constituent- laden stormwater runoff and offsite flooding.

The evaluation was based on the findings of available literature and data review supplemented by observations made during a reconnaissance site visit. Key observations from the assessment are summarized and discussed below:

5.1 Surface Hydrology and Flooding Potential

With two exceptions (the Bubulao and Malaja Rivers) all other named rivers (Talisay, Bonya, Tinechong, Sarasa, and Sagge) that receive flows from the proposed range footprints have FEMA-designated Zone A floodplains. Typically development within a FEMA-designated Zone A requires detailed topographic surveys, a hydraulic study of the reaches to determine a more accurate extent and elevation of the existing 100-year floodplain, and potentially floodplain permitting. All proposed LFTRC footprints are located upstream of the respective FEMA designated floodplains. **Based on this reconnaissance-level assessment it does not appear that development of these areas is very likely to raise the 100-year water surface elevations within the respective FEMA-designated Special Flood Hazard Areas**. This projection will, however, have to be verified through a detailed hydraulic and hydrologic (H&H) modeling study after a preliminary design is developed. Any rise in the elevations is covered by FEMA regulations and would need to be approved by the local floodplain administrator.

It should be noted that, even though all proposed footprints are located upstream of the FEMA designated floodplain, this does not necessarily preclude flooding from occurring along sections of the rivers and streams that lie in the immediate vicinity of the proposed ranges. Unless appropriate site-specific BMPs and LID measures are implemented, it is possible that such localized flooding could potentially inundate the firing range and cause sediments and munitions-constituents to be carried offsite. See **Section 4.4** for a list of BMPs and LID measures that can be considered for implementation at individual range sites to control soil erosion, manage sediment- and munitions-constituent mobilization by stormwater runoff, and reduce stormwater runoff volume and velocity.

5.2 Soil Erosion Potential

The areas proposed for locating the NS-Alignment Ranges are generally located on soils with naturally low soil erosion potential. Also, these areas are currently covered with dense vegetation. Therefore, at this time, these areas are characterized by very low soil erosion potential. If the vegetation in this area is removed during construction, it would expose the soils to the elements making them more prone to erosion.

The areas proposed for locating the EW-Alignment firing ranges are located on various types of Akina soils, which are highly susceptible to erosion and can produce high concentrations of very fine clay suspended sediments. Also, these areas are extensively covered by savanna grasslands interspersed with barren lands (badlands), both of which can potentially be a major source of soil erosion. Similarly, many of the areas proposed for locating the L-Alignment Ranges are characterized either by Akina soils, which are extremely erodible, especially on steep slopes, and/or covered by savannas grasslands interspersed with badlands. Both these factors make these areas highly prone to soil erosion. Removal of vegetation during constructions would further exacerbate existing soil erosion potential. Implementation of appropriate BMPs during construction and operations can substantially improve erosion issues within the proposed range footprints.

5.3 Soil Geochemistry (Lead Mobilization Potential)

Compared to the other two alignments, the areas proposed for locating the NS-Alignment Ranges are characterized by slightly higher pH and lower CEC values, which indicates relatively lower lead mobilization potential. This is also true for the dispersion areas associated with the proposed NS-Alignment footprints.

5.4 Fire Susceptibility

All proposed footprints for the NS-Alignment Ranges are located within the NMS, which is characterized by dense forest vegetation, a significant road network, and restricted access. These three factors together contribute to a lower risk of arson fires, which plague many of the other upland, savanna-grassland dominated watersheds in Guam. Most of the EW- and L-Alignment footprints are located outside the NMS boundaries and these areas are extensively covered with savanna grasslands which are highly susceptible to arson fires. Once the existing vegetation, which serves as a natural erosion control barrier, is lost to fire, the exposed soils become more erosion prone.

5.5 Natural Environment

Several of the proposed footprint areas are located in or around natural wetlands that may be adversely impacted due to construction and operation of a firing range. Reconnaissance-level data evaluation indicates that developing the proposed range footprints for the NS-, EW- and L-Alignments Ranges could potentially impact approximately 13, 8, and 4 ac of wetlands, respectively. Loss of wetland acreage not only means loss of natural biological functions but also reduced natural stormwater sediment-filtration capacity.

5.6 Threatened and Endangered Species

For Guam, ten terrestrial species are listed as endangered and one threatened under the Federal ESA. These ten plus an additional 20 other terrestrial species (for a total of 30) are listed as endangered under the Guam ESA (See Section 3.2.2 and 3.2.3). A few of these species, such as the endangered Mariana common moorhen, have been documented within the LFTRC study area. Others such as the federally endangered and Guam-endangered Mariana swiftlet and the federally threatened and Guam-endangered Mariana fruit bat may potentially use portions of the study area.

Natural areas suitable for use by several other threatened and endangered species are also present within the study area. Therefore the presence of additional threatened and endangered species within the study area cannot be ruled out at this stage. Detailed and focused threatened and endangered species surveys may have to be conducted during subsequent planning phases to determine population sizes and distribution of all the threatened and endangered plant and animal species that may potentially occur within the study area.

The areas proposed for locating individual range footprints for all three alignments include varying amounts of natural areas that may potentially be utilized by several federally and Guam-threatened and endangered species. Additional habitat that may be suitable for use by threatened and endangered species may also be present in between the proposed range footprints.

5.7 Conclusions and Recommendations

Major conclusions from this reconnaissance-level assessment are discussed below. Recommendations for implementing site-specific BMPs at the proposed LFTRC ranges were previously discussed in Section 4 and these are also summarized below.

- None of the proposed range footprints for the three alignments actually fall within the CTW (**Figure 2**) and therefore it is highly unlikely that stormwater runoff from any of the proposed footprint areas will drain to the FVR. The reservoir water quality should therefore not be impacted due to the construction and operation of the proposed LFTRC.
- For the proposed LFTRC, adverse impacts may potentially be caused by siting, construction, and operations of the individual firing ranges.
- Siting-related impacts can be substantially reduced by refining/relocating the proposed range footprints.
- Implementation of site-specific BMPs at strategic locations should substantially ameliorate many of the projected potential adverse impacts associated with construction and operations of the proposed ranges.
- Incorporation of LID design technology, which makes use of innovative methods to retain and manage stormwater onsite, in the final facility design will also help in eliminating or reducing potential adverse impacts associated with range operations.

- It is anticipated that developing the proposed footprint areas will not impact water surface elevation levels in FEMA-regulated floodplains; however detailed H&H modeling needs to be conducted to verify this assertion.
- During subsequent planning phases, focused biological surveys may have to be conducted to determine presence and distribution of threatened, endangered, and candidate species.

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ATTACHMENTS

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Attachment A

Site Reconnaissance Visit Photo Log

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Photo A-1: NS/L-Alignments MPMG Range – Looking downrange from proposed firing line

Photo A-2: NS/L-Alignments MPMG Range – South from Alifan and Blandy Road

Photo A-3: NS/L-Alignments MPMG Range – East from Alifan and Blandy Road

Photo A-4: NS/L-Alignments MPMG Range – East from Blandy Road at edge of proposed range

Photo A-5: NS/L-Alignments MPMG Range – Talisay River downstream view

Photo A-6: NS/L-Alignments MPMG Range –Typical forest, south from Blandy Road

Photo A-7: NS-Alignment KD Rifle Range – View of Swordgrass savanna and *Pandanus* swamp

Photo A-8: NS-Alignment KD Rifle Range – Looking SE along Bone Springs Road from Talisay River

Photo A-9: Verifying vegetation mapping along Talisay River

Photo A-10: NS-Alignment KD Rifle Range – Wetland area south of Hardstand Road

Photo A-11: NS-Alignment KD Rifle Range – Vegetation within the proposed range footprint

Photo A-12: NS-Alignment KD Rifle Range – Looking SW at Hardstand culvert along east side of proposed range footprint

Photo A-13: NS-Alignment KD Rifle Range – Upstream view of Hardstand culvert along east side of proposed range footprint

Photo A-14: NS-Alignment MRF Range – Looking downrange from right half firing line

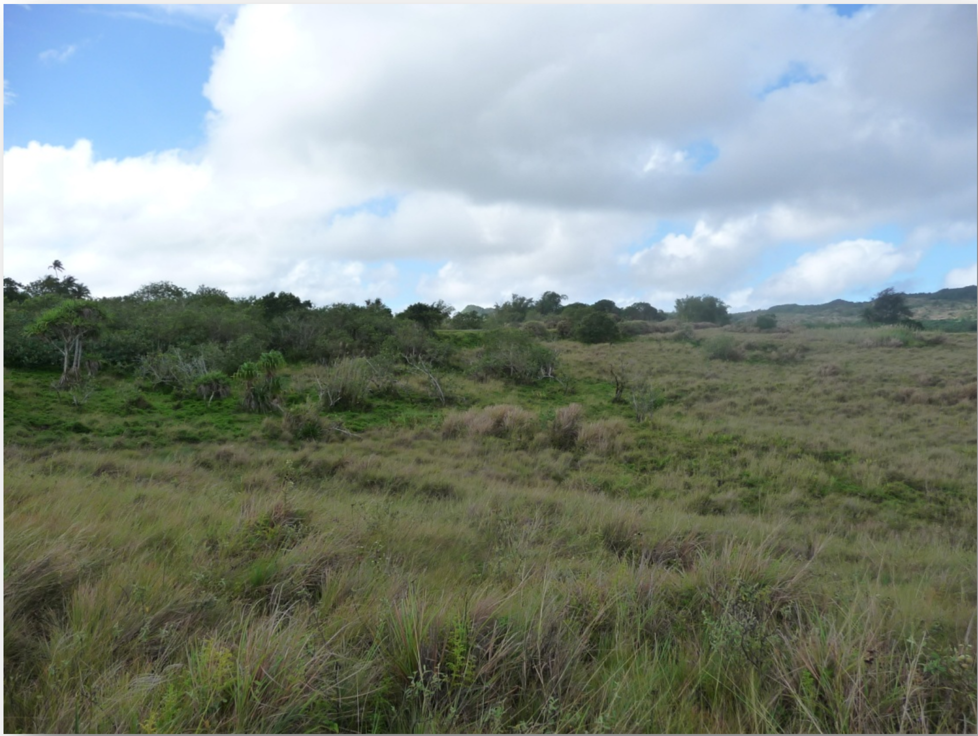

Photo A-15: NS-Alignment MRF Range - Looking downrange from left half firing line

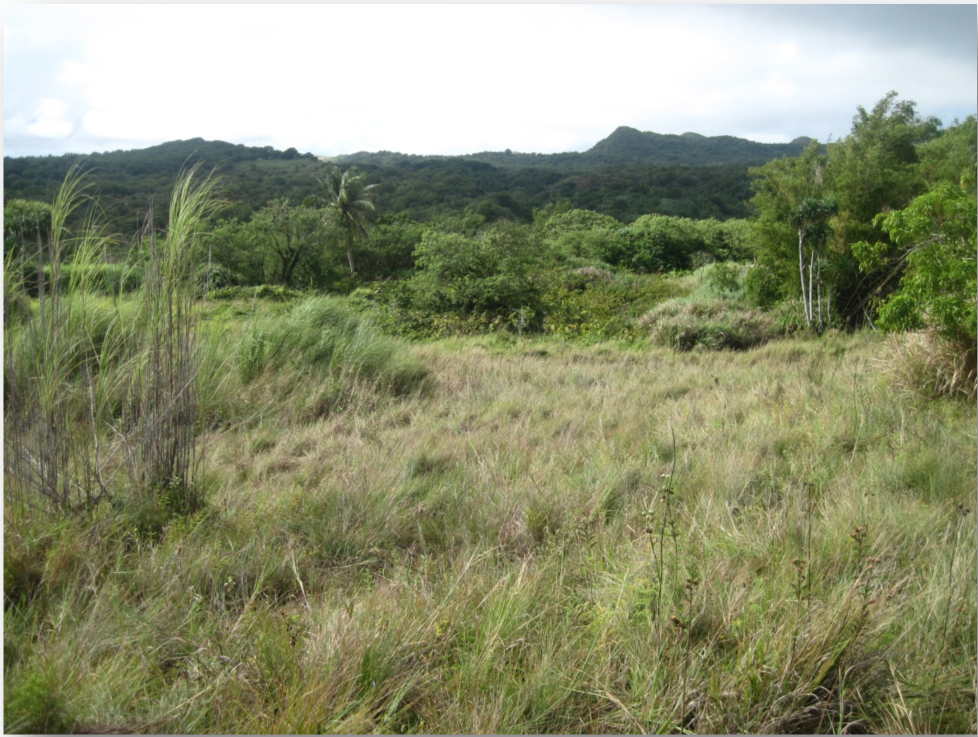

Photo A-16: NS-Alignment MRF Range – Looking downrange from mid-range hilltop

Photo A-17: NS-Alignment MRF Range – Pond located at firing line and partially within range

Photo A-18: NS-Alignment MRF Range – Moorhens in pond

Photo A-19: Looking north/northeast from Mt. Jumullong Manglo over study area

Photo A-20: Looking northeast from Mt. Jumullong Manglo over study area

Photo A-21: Looking east/northeast from Mt. Jumullong Manglo over study area

Photo A-22: EW-Alignment – Proposed footprints are located in the center of the photo

Photo A-23: EW-Alignment – Proposed footprints are located in the center of the photo

Photo A-24: Looking east from Mt. Jumullong Manglo

Attachment B

LFTRC Proposed Range Footprints

Characterization of Existing Conditions and Discussion of Relevant Issues

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ATTACMENT B

LFTRC Proposed Range Footprints
Characterization of Existing Conditions and Discussion of Relevant Issues

TABLE OF CONTENT

LIST OF FIGURES

1.0 INTRODUCTION

Additional information on drainage, flooding, grading, and erosion issues associated with each proposed range footprint is presented in this Attachment. Preliminary estimates of cut and fill requirements for each range type are also included. **Note that all information contained in this Attachment is based on desk-top GIS analyses of individual footprints supplemented by findings of the literature and data review and observations made during the February 2012 site reconnaissance visit. Therefore this information should be considered notional. It should be vetted and verified after relevant additional site-specific data has been collected and analyzed.**

For each range type, varying amounts of earthwork are likely to be required to mitigate line-of-sight issues and for construction of impact and firing berms, access routes, and staging areas and implementation of engineered drainage and erosion- and sediment-control solutions. The earthwork requirements for each range type will primarily depend upon the existing terrain and the nature of the firing activities that will occur on each range. Salient information on individual range types that will influence earthwork requirements is summarized below:

- **KD Rifle –** Will be used to support annual rifle qualification and therefore the range must be designed to have at least three firing lines and one fixed target line. Firing in between the firing lines is not likely, and therefore, terrain, drainage, and vegetation can exist so long as it does not impede the line of sight of the range. The entire range may not need to be disturbed.
- **Pistol Range –** Will be used to support pistol qualification. Unlike the KD Rifle, firing distances are short and the entire range will likely need to be leveled.
- **HG Range –** Layout is driven by the structural requirements of a contained impact area and the appropriate throwing pits. While the thrower is protected by ducking down into the throwing pit, the impact/containment berm must protect personnel and property on the range. Impact area needs to be clear to minimize blast debris and to easily locate duds.
- **Small Arms Range –** Likely utilized for a variety of training to include a portion of the annual rifle qualification. The short length of this range and its flexibility requires a flat and clear surface. Line-of-sight issues cannot be tolerated. Undulating terrain and gullies with vegetation may minimize area available for training.
- **MRF Range –** Will support a greater variety of training and weapon systems. Since this range type is not tied to a Marine Corps annual training requirement, the physical layout of this range is not rigid. It can therefore be designed to make the best use of existing terrain, provided line-of-sight conflicts are minimized. Undulating and varied terrain can enhance the realistic nature of the training.
- **MPMG Range –** Known- and unknown-distance engagement of targets will occur throughout the target area, but primarily beyond 300 yards. Firing will occur from fixed firing locations at one end of the range. Targets of mixed type will be scattered through the engagement area. Undulating terrain, presence of vegetation, and some line-of-sight issues due to natural features (ravines and gullies) are not major limiting factors as long as they do not fully impede line of sight to the targets. The entire range footprint may not need to be disturbed.

2.0 NS-ALIGNMENT

The proposed footprints for the six NS-Alignment firing ranges are located in the northern portion of the Talofofo Watershed (**Figure B-1**).

2.1 NS-Alignment – KD Rifle Range

The proposed range footprint is oriented northeast to southwest and is located at the intersection of Bona Springs and Hardstand Roads (**Figures B-1**, **B-2** and **B-3**).

2.1.1 Surface Hydrology and Flooding Potential

The Talisay River channel cuts through the proposed range footprint (**Figure B-3**). The river gradient in this area is gentle and the main channel is diffused among the wetlands that line the banks. Hardstand Road generally bisects the range and splits the drainage in this area.

South of Hardstand Road, runoff collects in a depressed wetland area, which drains east under the road via a 24-inch reinforced concrete pipe. The wetland and lateral flows together drain into the Talisay River. During the site visit, some flow from this wetland was also observed to seep through the embankments surrounding a bunker pad. This seepage appears to drain into a small, concrete-lined ditch, which carries the flow around the bunker into a roadside ditch, from where the flow is piped under Hardstand Road.

Land north of Hardstand Road generally drains east and northeast to the wetland areas of the Talisay channel (**Figure B-3**). In this area, the river channel is not as steeply sloped, and large inundated stands of *Pandanus* are present along either side of the channel. In this stretch, the river channel is rather undefined, with the exception of the Bona Springs Road crossing where a 36-inch reinforced concrete pipe provides drainage under the road.

Given its proximity to the river channel, flooding could be a serious concern if a range were to be sited at this location. Regular inundation of the range footprint would most likely occur unless the entire river was routed around the proposed footprint. Range operations would be impacted during flooding events as the 500-yard line and range house would be on the wrong side of the river. Transition between firing lines during the course of fire and transitions between relays could be interrupted. The wetland areas south of Hardstand Road would also be regularly inundated.

2.1.2 Existing Terrain and Grading Issues

The terrain in this area gently slopes uphill from the firing line to the target area and beyond. Currently, the lowest elevation of the proposed range footprint is located along the 500-yard firing line (north end) and the highest elevation is located along the target line (south end), with an elevation difference of about 40 feet (12 meters). This implies that that target line will have to be graded down to a lower elevation and the 500-yard firing line will have to be raised to facilitate a level surface for shooting (**Figure B-3**).

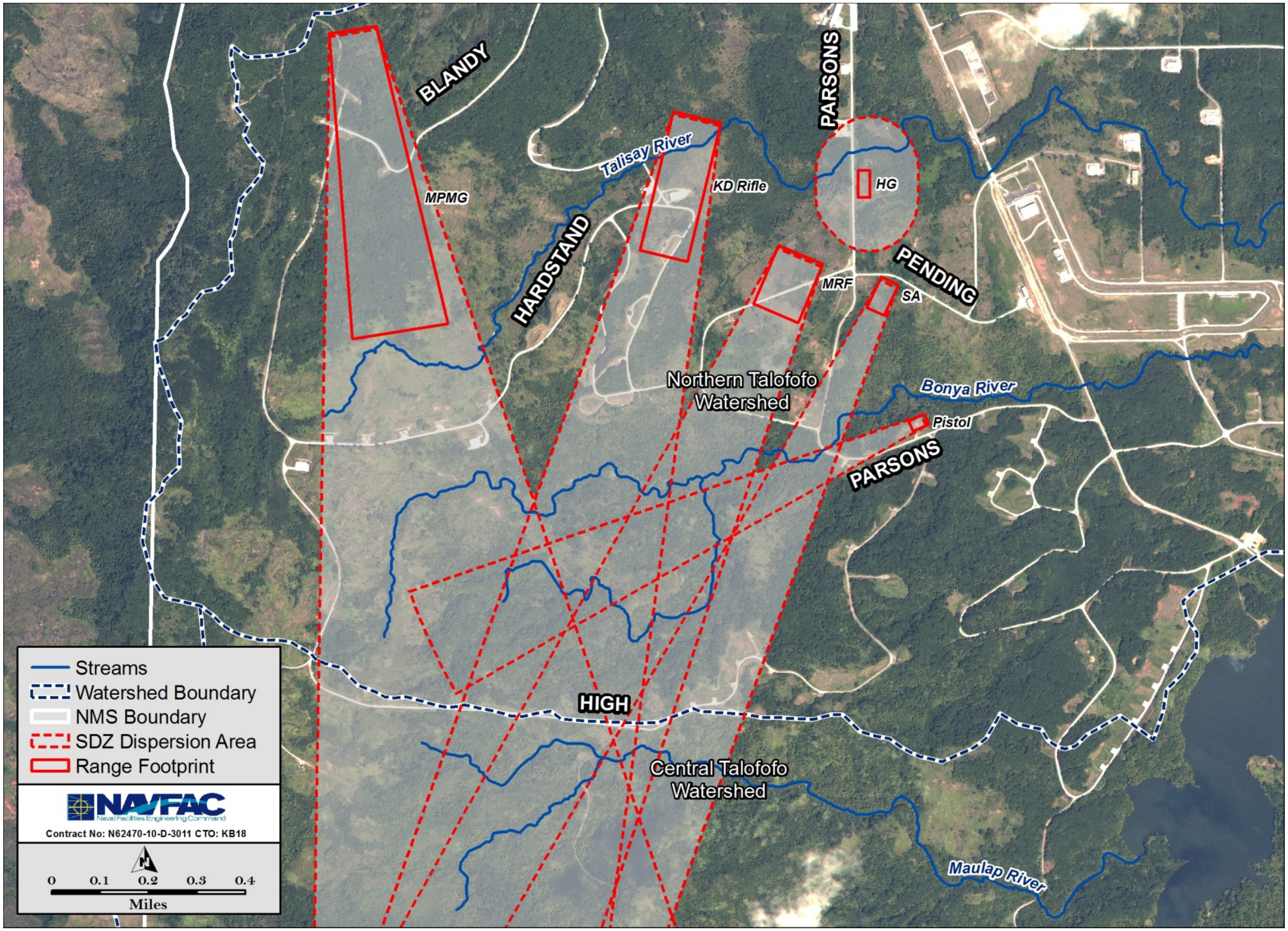

Figure B-1: LFTRC NS-Alignment Proposed Range Footprints

Figure B-2: Downrange Views – Looking towards the intersection of Bona Springs and Hardstand Road and over the top of the southern wetland

Marine Corps KD Rifle Ranges typically have firing lines at 200, 300, and 500 yards, and an optional 100-yard Battle Sight Zero firing line. Each firing line is typically elevated above the firing lines to the front, to reduce the risk of range interference with rounds traveling downrange. Therefore, it is likely that the 500-yard firing line at this site would need to rest higher than the target line, as well as the other two firing lines. This means a greater amount of fill will have to be placed in this area. The 200- and 300-yard firing lines would need to have elevated berms.

Much of the proposed range footprint between the firing lines and the target line could be left undisturbed. An area between the target line and the impact berm would need to be excavated to facilitate scoring and target operations. Targets will be placed on target carriages and raised and lowered by the non-firing relay. Additional excavation will most likely be required for this area.

2.1.3 Soils

Inarajan clays (0 to 4 percent slopes) and Akina silty clays (7 to 15 percent slopes) are the predominant soil types in the area. Inarajan clays occur along the Talisay River channel towards the firing line and are characterized by very deep, poorly drained soils, typical of valley bottoms. The risk of water erosion associated with this soil type is "slight." Akina silty clays dominate the rest of the proposed range footprint. They are characteristically located on volcanic uplands and are very deep and well drained. The risk of water erosion associated with this soil type is generally characterized as "moderate" and runoff properties are listed as "medium."

2.1.4 Site Drainage

As compared to the other types of ranges, a KD Rifle Range is much more likely to effectively contain its projectiles because they generally tend to stay concentrated within the impact berm behind the target line. Therefore only the target line and impact berm area would have to be hydrologically isolated from the offsite drainage to prevent runoff from getting contaminated by spent ammunition.

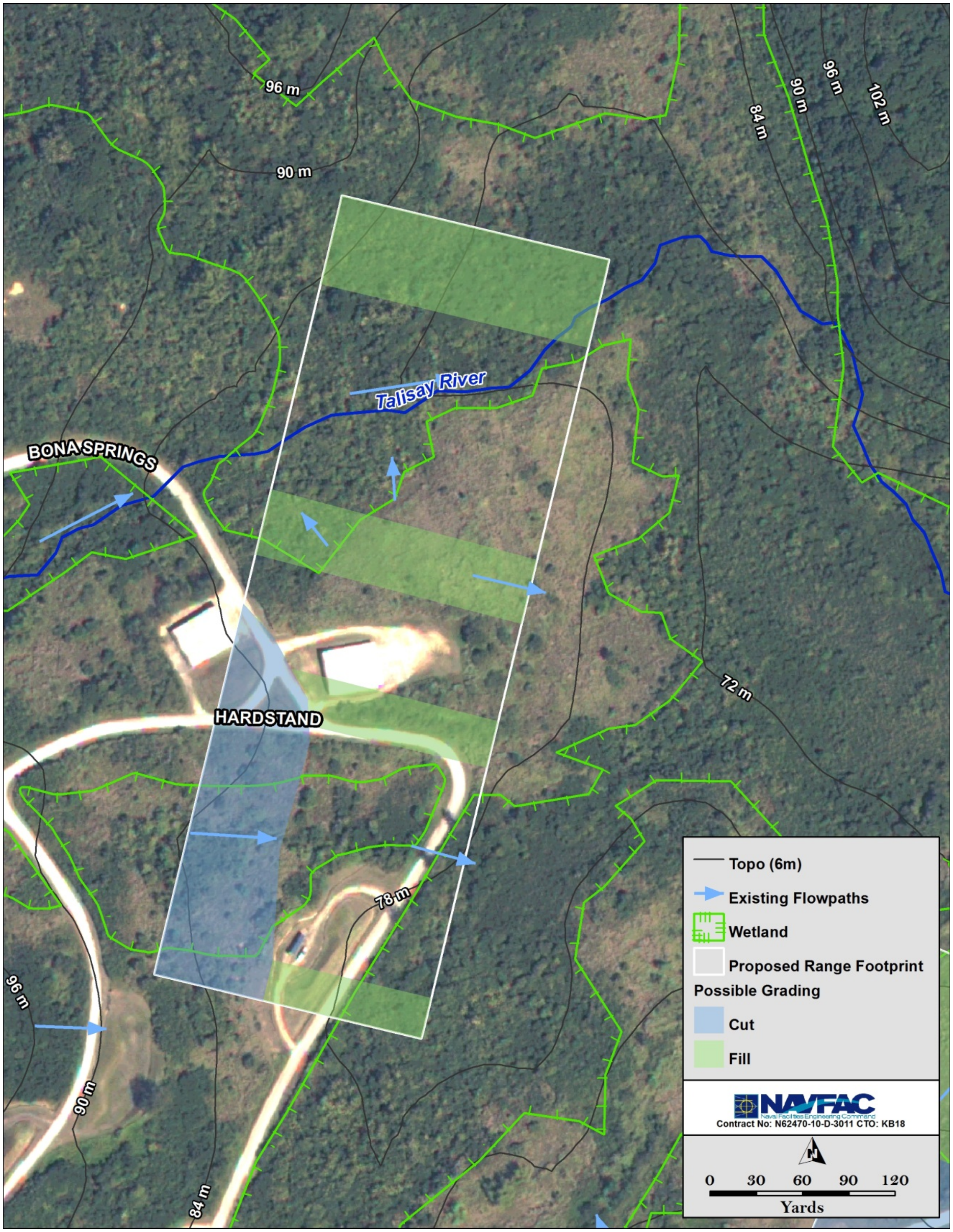

Figure B-3: NS-Alignment KD Rifle Range Proposed Footprint – Existing Drainage Patterns and Potential Grading Requirements

The target line and impact berm area would most likely be excavated below the existing surface. Offsite drainage could be channeled into a perimeter swale and routed to the far downstream side of the target line.

Other developed areas such as the access road within the range, the firing lines, and the staging area behind the 500-yard line are located on higher elevations and therefore offsite stormwater flows in these areas would not have to be segregated and rerouted.

Onsite drainage from the target line area could be collected via a vegetated swale and routed into a detention basin along Hardstand Road. A constructed wetland could be used to capture eroded sediments and mobilized particulate lead. A controlled outlet for the constructed wetland that is located to the east of Hardstand Road would most likely not overwhelm existing flow patterns in this gently sloped and heavily vegetated area.

Channeled flows from the remainder of the built-up areas of the proposed range (firing lines, staging area/range house, and the internal access roads) could be routed into a separate swale system and detention basin. Due to the elevated nature of these facilities, a drainage system could be designed to route flows to the center of the range, along the eastern boundary. A basin could be located within the savanna area. Multiple outlets and swales could introduce this flow to the constructed wetland to the east in a diffused manner, with the goal of not overwhelming the exiting flow regime. Similar to the target line drainage, this introduced flow would likely dissipate into the inundated areas of the constructed wetland.

The Talisay River channel would need to be re-routed where it currently leaves the range footprint. Relocating the channel to the south to avoid the 500-yard line, staging area, etc. would be necessary to prevent potential contamination from leaving the site. Routing the river through culverts and under these areas is an option, but larger storm events would still need to have the ability to flow around the raised range areas.

2.2 NS-Alignment – HG Range

The proposed HG Range footprint is located north and east of the intersection of Parsons Road and Pending Road (**Figure B-1**).

2.2.1 Surface Hydrology and Flooding Potential

The proposed footprint is located upslope of the fringe wetlands along the Talisay River and it generally avoids the main channel of the Talisay River as well as its wetland buffer. Overall, the proposed footprint area appears to have low flooding potential; however some peripheral areas of the proposed footprint may still be subjected to periodic inundations.

This area mainly receives runoff from the south and possibly drainage from Parsons Road to the west. The offsite flows and runoff from the area proposed for locating this range flows north-northeast into the wetlands surrounding the main river channel (**Figure B-4**). At least some of the offsite flow appears to be associated with adjacent badland areas that may be highly susceptible to erosion.

2.2.2 Existing Terrain and Grading Issues

The proposed footprint is located on a hillside that slopes towards the Talisay River (**Figure B-4**). Small amounts of cut and fill would be required at this location. Raising the north end of the range with fill as part of a balanced cut-and-fill plan will substantially reduce the flooding risk at the proposed range.

2.2.3 Soils

Inarajan clays (0 to 4 percent slopes) and Akina silty clay (7 to 15 percent slopes) are the predominant soil types in this area. The Inarajan soils occur along the Talisay channel and the Akina silty clays dominate the slope areas. Runoff and soil erosion potential ranges from slight (Inarajan clays) to moderate (Akina silty clays).

2.2.4 Site Drainage Issues

Given its proximity to the Talisay River channel, drainage patterns across the proposed footprint area will have to be appropriately managed. Ideally offsite flows from higher elevations in the area would completely bypass the proposed range (to prevent stormwater contamination) and discharge into the river as naturally as possible. Since the river bottom is fairly flat and vegetated, impacts from deflecting this offsite sheet flow are not projected to be severe.

Onsite flows should be detained and metered to prevent unnatural spikes in the runoff hydrograph. The impact area where the grenades will be thrown should be kept clear of potholes and craters. Drainage from the impact area could be routed through a vegetated swale to a small, constructed wetland basin to help remove any particulates. Most of the site could be well-vegetated or covered with a permeable pavement. Only the impact areas for live grenades would need to be cleared and may therefore become susceptible to erosion.

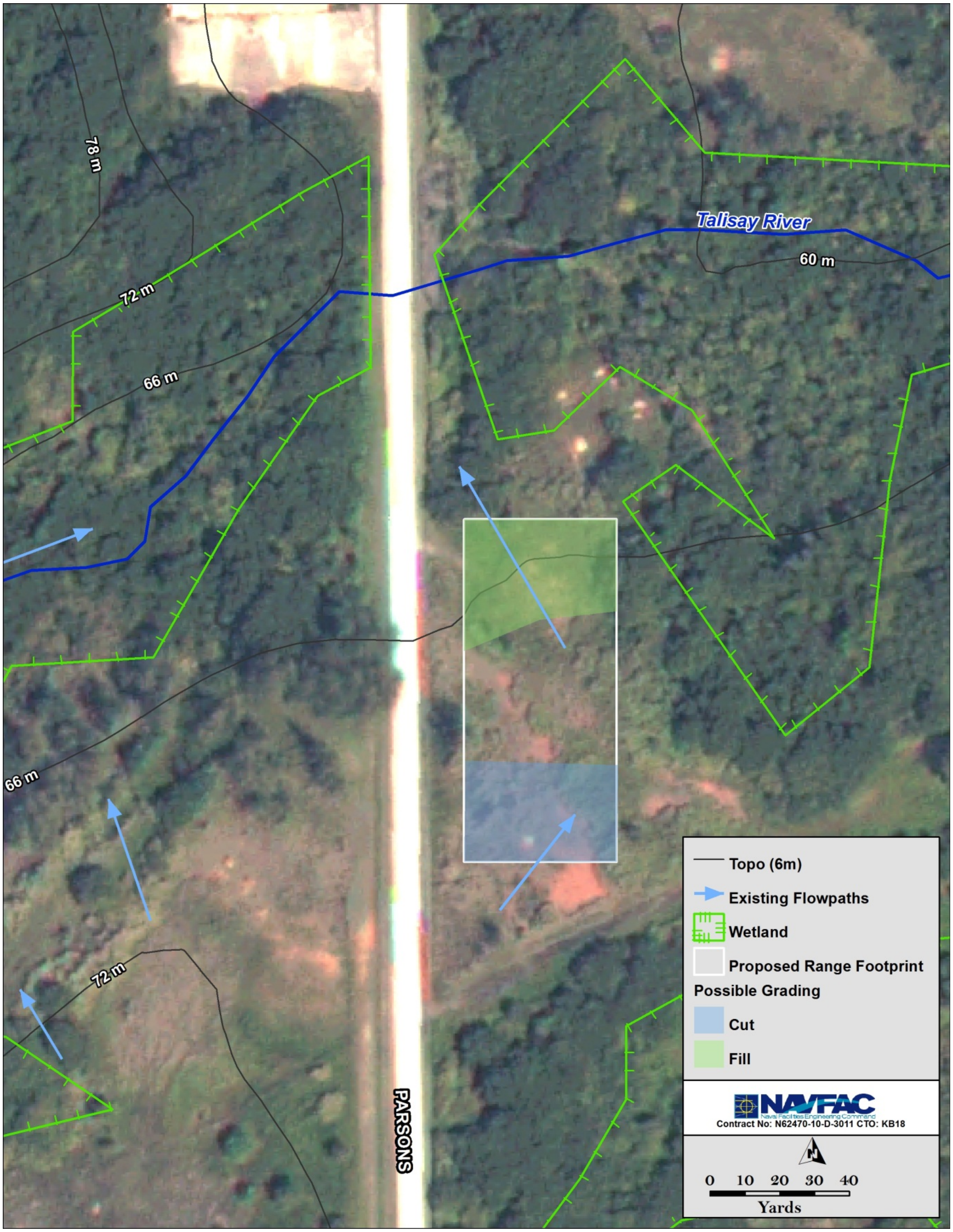

Figure B-4: NS Alternative HG Range Proposed Footprint – Existing Drainage Patterns and Potential Grading Requirements

2.3 NS-Alignment – Pistol Range

The proposed Pistol Range footprint is located at the intersection of Parsons and High roads (**Figures B-1** and **B-5**) at the site of an existing munition storage bunker. The left picture in **Figure B-5** depicts the downrange view. The Bonya River channel is located south of this site. The right picture in **Figure B-5** is an upstream view of the Bonya River channel.

Figure B-5: Downrange view bunker pad (left) and the Bonya River immediately down slope of the proposed footprint (right)

2.3.1 Surface Hydrology and Flooding Potential

The proposed footprint is located on a cleared site that is situated on higher ground above the Bonya River channel (**Figure B-6**). Therefore this area is not likely to receive substantial offsite flows, resulting in low flooding potential. The runoff in this area generally flows northeast away from the proposed footprint and towards the Bonya River.

2.3.2 Existing Terrain and Grading Issues

This footprint is located on previously developed and cleared land. Minimal grading would be required during range construction. Excavating adequate amount of fill to construct an impact berm may be the only significant earthwork required at this location.

2.3.3 Soils

The proposed footprint is located almost entirely on Akina silty clays (7 to15 percent slopes). Runoff and erosion potential are moderate.

2.3.4 Site Drainage

Expended rounds and lead fragments are likely to be well contained within the impact berm of due to the short firing distance and the ammunition type (9 mm ball) used at a pistol range. The accumulated lead can potentially contaminate stormwater runoff from this area, especially if the berm is not sheltered from the rain. Therefore, the runoff from this area may have to be segregated, subjected to appropriate BMPs, and then discharged back into the Bonya River.

Figure B-6: NS Alternative Pistol Range Proposed Footprint – Existing Drainage Patterns

2.4 NS-Alignment – Small Arms Range

The proposed Small Range footprint is located east of the intersection of Parsons and Pending roads and is generally oriented northeast to southwest (**Figure B-1**).

2.4.1 Surface Hydrology and Flooding Potential

The proposed footprint is located on gently sloping high ground straddling the Talisay River and Bonya River divide and therefore this area is not likely to receive substantial offsite flows. Most of the drainage from this area flows south towards the Bonya River (**Figure B-7**). A small portion flows towards the north across Pending Road and into the Talisay River. Overall this area has low flooding potential.

2.4.2 Existing Terrain and Grading Issues

The footprint is located on a north to south down-slope. It is important that this range is level, as targets could be situated at almost any location beyond the firing line. The downrange end will have to be filled to level off the target area and to construct the impact berm (**Figure B-7**). The short firing range associated with this facility makes an impact berm more likely to be successful. The proposed location is suitable for constructing a berm that wraps around three sides of the range.

2.4.3 Soils

This footprint is located entirely on Akina silty clays (7 to 15 percent slopes), which are characteristically located on volcanic uplands and generally are very deep and well drained.

2.4.4 Site Drainage

Currently, most of the runoff in this area flows south towards a well-defined ravine leading to the Bonya River (**Figure B-7**). Offsite drainage issues for this footprint are likely to be minimal and could be effectively dealt with by simply routing the flows around the proposed range via grassy swales. As long as the diverted flows are introduced into the existing slopes adjacent to the footprint, no significant additional modifications are likely to be necessary.

Drainage from the developed areas on the range could be collected by vegetated swales and channeled to a single location from where it could enter a constructed wetland. Such a wetland could provide filtration and serve as a detention basin. Flows from the constructed wetland could be metered through a control outlet structure.

Figure B-7: NS Alternative – Proposed Small Arms Footprint Existing Drainage Patterns and Possible Grading Requirements

2.5 NS-Alignment – MRF Range

The proposed MRF Range footprint is oriented northeast to southwest and is located roughly in the vicinity of Pending, Hardstand, and Parsons Roads (**Figures B-1** and B-**8**). The area shown in the left photo in **Figure B-8** is located behind the proposed firing line adjacent to a pond. The photo on the right was taken from the top of a hill, looking south-southwest at the proposed range footprint. The terrain drops off towards the far end of the proposed range.

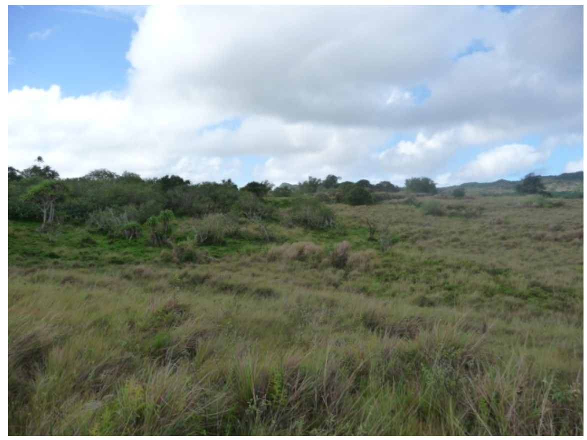

Figure B-8: View from the firing line towards the target area (left) and from within the footprint looking towards the downrange end (right)

2.5.1 Surface Hydrology and Flooding Potential

An elevation difference of approximately 40 feet exists between the firing line and the target line in some locations. From the target line, flows along the northwest, north, and northeast slopes of the hill generally converge towards two gullies within the proposed footprint and are channeled into the wetlands over a sharp drop. The wetlands eventually drain to the Talisay River, which at this location, is a low-gradient marsh of inundated woody vegetation.

The wetlands along the river banks lie in the river's floodplain and appear to be located down slope of the footprint. Flooding concerns with respect to the open-water pond immediately behind the firing line may be reduced by elevating the end of the range. Due to the elevation of the proposed MRF Range, there does not appear to be a significant risk of flooding in this area.

2.5.2 Existing Terrain and Grading Issues

The range is situated on a hillside which slopes north-northeast towards the Talisay River. The lowest end of the firing line currently sits about 40 feet (12 meters) lower than the highest point within the target area (**Figure B-9**). A cut-and-fill regime will be needed to provide a level range facility. The excess cut material could be used to fill the firing line at the northern end. This would result in an elevated firing line, and a large amount of the downrange end lowered. The resulting cut slope around the end of the range could enhance the effectiveness of a constructed range berm.

The firing line, however, would require a large fill slope, which could increase the size of the range footprint. A small open water pond that is present within the footprint would likely have to be filled in or encroached upon. The area between the 0- and 50-yard lines in front of the firing line is likely to be devoid of targets and therefore would not need to be brought up to shooting level.

2.5.3 Soils

The proposed footprint is located almost entirely on Akina silty clays. Runoff and erosion potential are moderate.

2.5.4 Site Drainage

Projectiles at an MRF Range are likely to be more scattered throughout the target area and therefore there onsite flows from the entire target area will have to be sequestered and subjected to suitable BMPs prior to being discharged to the Talisay River. One option for this would be to collect flows from the target area, firing line, and staging area/range house via vegetated swales, which would converge on a detention basin. Channeling this runoff into a holding basin would allow for sedimentation and also reduce peak flows from entering into the Talisay system.

A detention basin could potentially be located northeast of the Parson/Pending intersection. An open water pond type design could be used; such a pond could potentially replace the existing open water area that may have to be filled in during construction. Flows from the detention basin could be released to the wetlands surrounding the Talisay River via a controlled outlet.

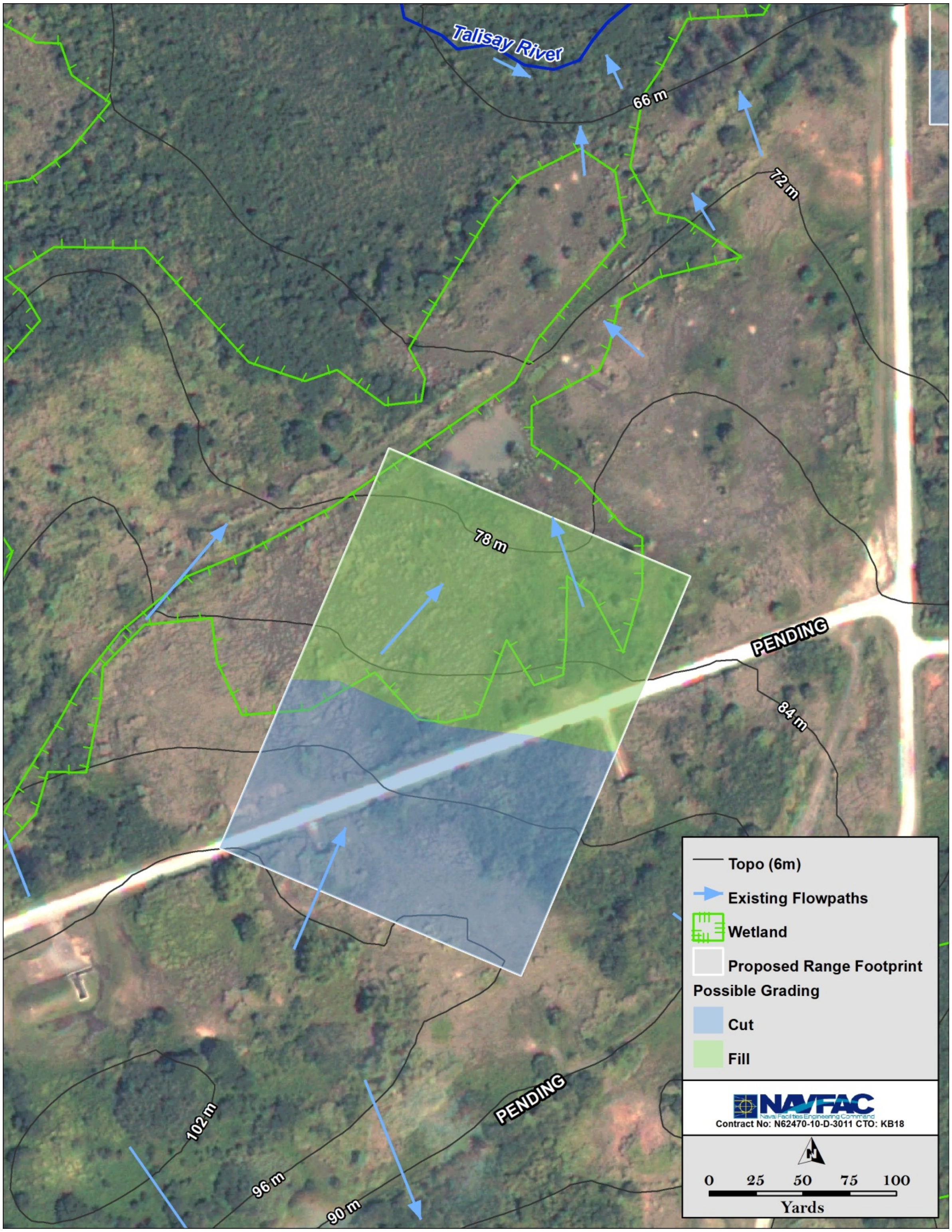

Figure B-9: NS Alternative MRF Range Proposed Footprint –Existing Drainage Patterns and Possible Grading Requirements

2.6 NS-Alignment – MPMG Range

The proposed MPMG Range footprint is oriented north to south and is located in the northwestern corner of the NMS just below Mt Alifan. It covers a substantial portion of the eastern slope of the Alifan Ridge (**Figures B-1**, **B-10**, and **B-11**).

Figure B-10: View from the firing line towards the target area (left) and from intersection of Blandy and High towards the downrange end

Figure B-11: Looking down from Blandy Road towards the firing line

2.6.1 Surface Hydrology and Flooding Potential

Mount Alifan and an adjacent ridge, which are located to the west, serve as the boundary of the drainage basin that contributes runoff towards the proposed range footprint (**Figure B-12**). The runoff in this area generally flows from west to east and is mostly carried in rivulets and small gullies through heavily vegetated areas. Most of this flow drains onto and across the footprint and drops sharply downhill to a large wetland area associated with the Talisay River. A small portion at the extreme south of the proposed footprint drains directly to the Talisay River.

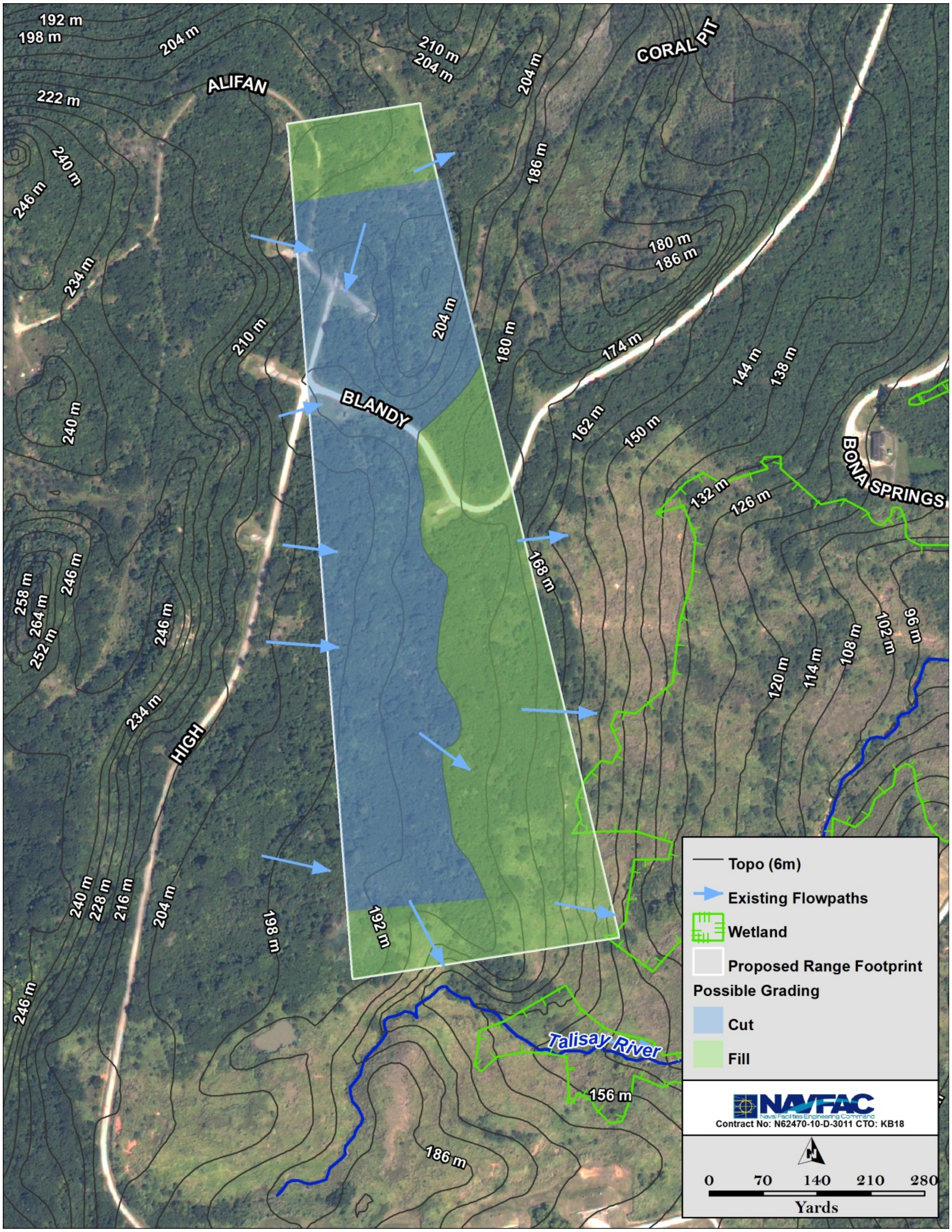

Figure B-12: NS Alternative MPMG Range Proposed Footprint –Existing Drainage Patterns and Possible Grading Requirements

Overall the area proposed for locating the NS-Alignment MPMG Range has low flooding potential. Flooding from the Talisay River may come up along the southern boundary, but would likely have little operational impact. The likelihood of lead accumulating in the southern extreme edge of this range, which may get flooded under extreme events, is slight because this edge is located well below the actual engagement area up on top of the slope and the area is probably going to be the opposite side of an impact berm. Flooding issues would have to be considered when designing the fill slope extending down into the southern area.

2.6.2 Existing Terrain and Grading Issues

The highest portion of the proposed footprint is a smaller, isolated ridge located towards the firing line end of the range. This ridge rises approximately 30 to 40 feet above the firing line area, and is almost wholly confined to within the proposed footprint. From the firing line, the terrain dips slightly to Blandy Road (**Figure B-12**). From Blandy Road to the downrange extent of the firing line, the range footprint is situated on a moderate to steep slope, sloping from right to left (west to east) with a difference of up to 115 feet (**Figure B-12**). The proposed footprint also takes a steep dip at the end of the range to the south, down to the Talisay River.

The isolated ridge located towards the north end rises approximately 30 to 40 feet above the firing line area, and is confined to within the footprint (**Figure B-12**). This small ridge would need to be reduced and the fill could be used to construct an elevated firing line.

The line of sight from the proposed firing line is difficult to determine due to the existing vegetation. There may be areas masked by terrain that are not visible from the firing line. Localized grading may be necessary. Assuming stationary targets such as tire stacks or vehicle hulks, the existing lay of the land could work for a MPMG Range, but would most likely not be ideal. In its current configurations, shooters would engage target arrays that slope from right to left. Also a containment berm of any nature would be difficult to implement on a sloping range. A berm at the extreme end of the range would require significant fill and engineering, as it would be situated on the slope leading to the river.

Grading the target area to provide a level engagement area would require a significant amount of earthwork. From Blandy Road south, a balanced cut and fill would approximately equate to a level area at 610 feet in elevation (186 meter). This would sit about 40 feet lower than the west side of the range, and about 20 to 100 feet higher than the east side of the range footprint. These rough estimations are intended to highlight the immense amount of alterations likely to be required to construct a traditional layout MPMG Range at this location. It is also likely that the proposed footprint may have to be expanded to accommodate the cut and fill slopes.

Raised berms across the width of the target engagement area could be used, and would require less overall grading. However, this would still require clearing of existing vegetation. An end-of-range containment berm would help reduce ricochets leaving the range, but would not likely provide complete containment.

Unknown-distance shooting with multiple targets scattered through the target area make for a higher likelihood of short rounds and therefore a higher risk of ricochet. A level target engagement area would increase the effectiveness of the berm. Pulling the berm north and shortening the range would provide a more realistic location for an impact berm, but the effectiveness would likely be limited to targets located directly in front of it. Targets located midrange would likely cause ricochets not contained by an end of range berm. Localized berms behind targets may be a better option. Additionally, target material will be an important consideration in an attempt to reduce ricochets.

2.6.3 Soils

This footprint is located almost exclusively on a Ritidian rock outcrop complex with 15 to 60 percent slopes. The NRCS reports that such formations are generally associated with shallow and well-drained soils that have a mixture of gravel, cobbles, and clay loam, with porous coral limestone resting a short distance below. Runoff is characteristically slow and erosion due to water is slight.

2.6.4 Site Drainage

Effectively precluding offsite drainage and containing all onsite drainage will most likely require substantial engineering because of the large and loosely defined target area of this range type. On-site runoff would be segregated and routed through strategically located BMPs. Offsite drainage would have to be dealt with appropriately to prevent concentrating flows and disrupting the downstream hydrograph, which could increase risk of flooding and erosion down slope. The Ritidian rock outcrop complex at this location and the associated porous limestone underneath may provide for small runoff volumes.

3.0 EW-ALIGNMENT

Areas proposed for locating the EW-Alignment Range footprints are generally located towards the southernmost boundary of the Talofofo Watershed (**Figure B-13**). The proposed MRF Range and portions of the proposed MPMG Range footprint extend into the Ugum Watershed. Many of the areas proposed for locating individual ranges for the EW-Alignment are privately owned and therefore could not observed at a close range during the site reconnaissance visit.

3.1 EW-Alignment – KD Rifle Range

The proposed KD Rifle Range footprint is located on private lands to the east of the NMS and the FVR (**Figure B-13**). A portion of the SDZ does extend into the NMS.

3.1.1 Surface Hydrology and Flooding Potential

The southern half of the proposed footprint area is drained via sheet flow to the Sarassa River and its peripheral wetlands. The gully flow and the sheet flow toward the north drain to what appears to be a wetland area around an unnamed stream. This unnamed drainage continues northeast for almost a mile before entering the Sagge River.

Local flowpaths are split north and south along the divide on which this range is located (**Figure B-14**). Some offsite flows are likely to enter to range footprint from the northwest and east, as the surrounding terrain slopes toward the range center. At least some of the offsite flow appears to be associated with badlands that are highly susceptible to erosion. A well-designed drainage system would reduce opportunities for localized ponding. No impacts to range operations are anticipated from flooding issues.

3.1.2 Soils

The proposed footprint is located mostly on Togcha-Akina silty clays (3 to 7 percent slopes), which are composed of 65 percent Togcha clay and 25 percent Akina silty clay. The Togcha soil is very deep and well drained, with moderate permeability and a surface layer of dark red and yellowish red silty clay. The Akina silty clay is also well drained, only moderately deep, and has a moderately slow permeability. Its surface is noted as dark, reddish brown silty clay. Runoff potential for both types of soils is listed as medium with a moderate water erosion hazard.

The other predominant soil type is the Akina-Badland complex, consisting of 65 percent Akina silty clay and 30 percent badland. The Akina soils are very deep and well drained, underlain by saprolite. Badlands are very susceptible to erosion with severe erosion potential rating from the NRCS. The Akina soils have a moderately slow permeability, with moderate to severe erosion hazard depending upon the slope class. Areas of badlands within the proposed range footprint occur on both the Akina-Badland unit and the Togcha-Akina series.

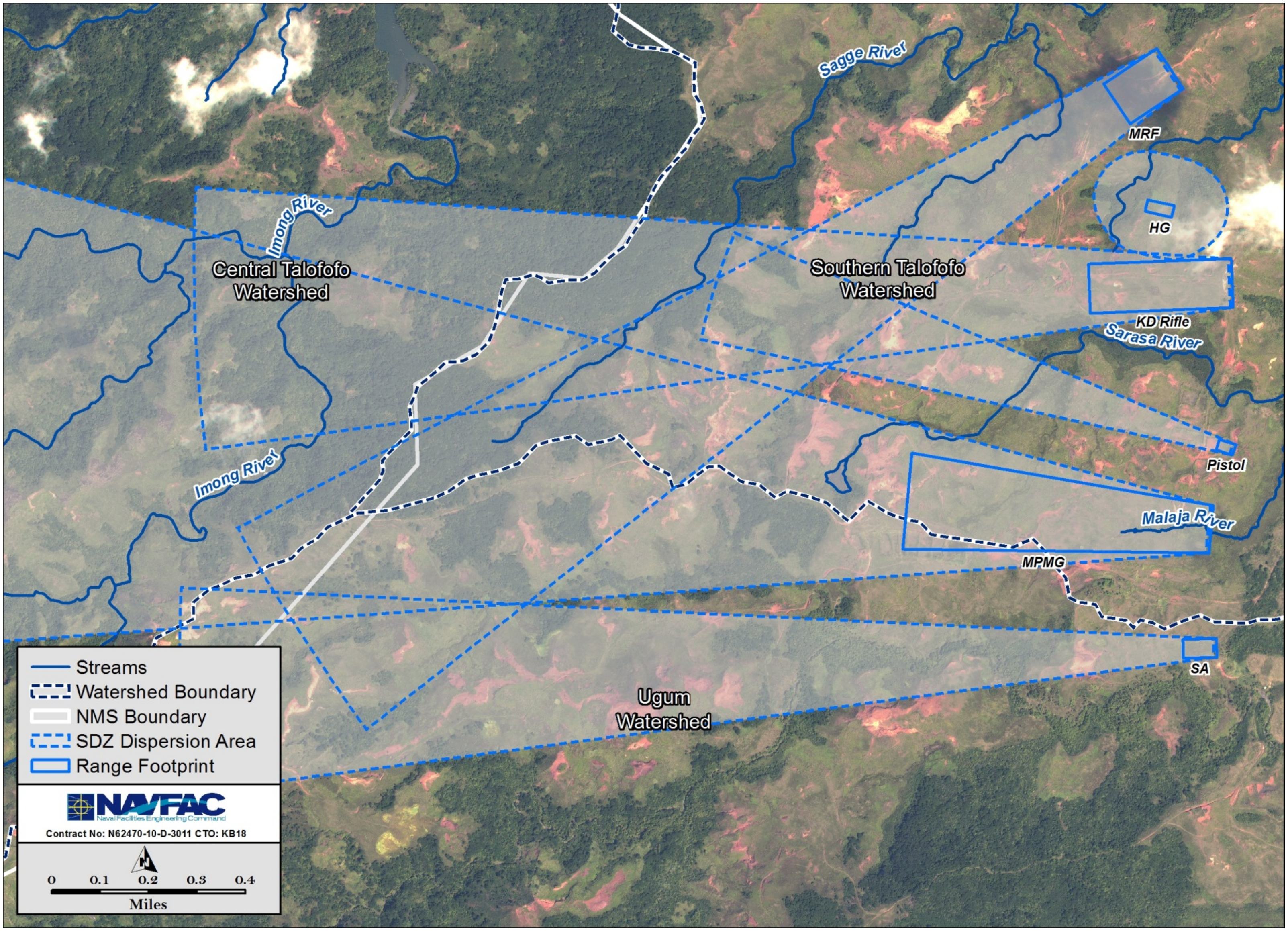

Figure B-13: LFTRC East-West Alignment Proposed Range Footprints

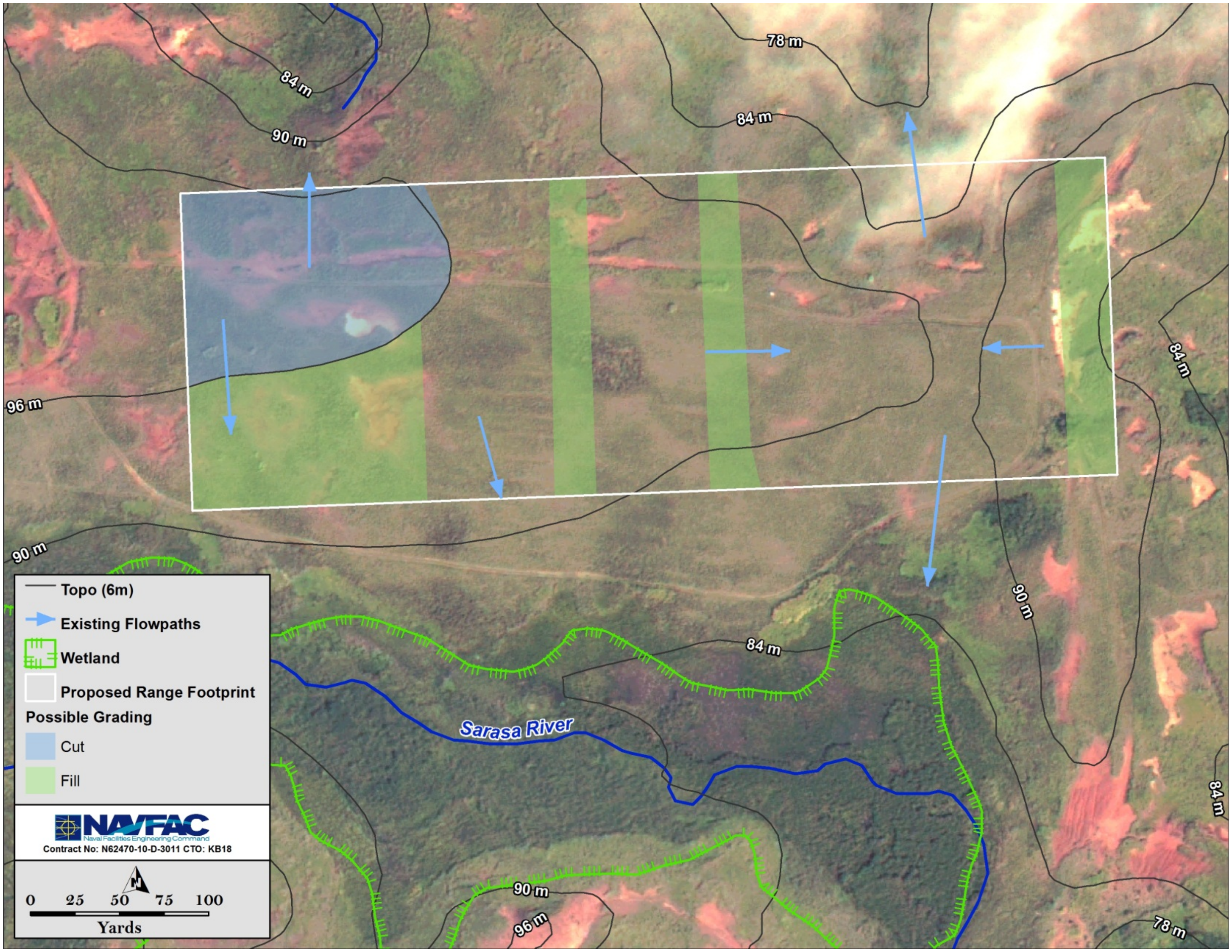

Figure B-14: EW-Alignment KD Rifle Range Proposed Footprint –Existing Drainage Patterns and Possible Grading Requirements

3.1.3 Existing Terrain and Grading Issues

The proposed footprint is situated on the crown of a west to east oriented ridge. This ridge dips slightly into a saddle at the eastern extent of the range. The proposed footprint is relatively flat between the firing line and target line. Terrain drops off along the long center axis on either side of the range (**Figure B-14**). Some cut and fill will be required at the target end of the range to support the target arrays, scoring area, impact berm, etc. The other operational areas of the proposed range (the firing lines at 200, 300, and 500 yards, the assembly area, and the pad for the range house) would also need to be leveled, with the firing lines raised in order to ensure proper line of sight to the target line.

3.1.4 Site Drainage

No significant concentrated flows cross the proposed footprint (**Figure B-14**). The greatest concentration of flow from the range itself would drain north or south from the saddle located between the 300-yard and 500-yard firing lines. The available topographic data indicates roughly a 2/3–1/3 split of flows between the Sarasa River to the south and the unnamed stream to the north.

Offsite flows will have to be guided around the target end of the range to prevent them from getting contaminated. Drainage between the firing lines will likely not be of too much of a concern.

Onsite drainage from the target line area could be collected via a vegetated swale and routed into a detention basin that is located towards the southern edge of the range. A constructed wetland and possibly a sand filtration system would capture these flows, alleviate any unnatural peaks in the hydrograph due to increased impervious areas, and provide some filtration of suspended particulates. Metered discharge from the constructed wetlands could be directed into the Sarasa River.

Onsite drainage from other developed areas, such as the firing lines, parking lot, staging area, and range house would need to be collected and detained to lessen impacts to the downstream flow rate. The remaining undeveloped areas of the range will have to be covered with appropriate vegetation to reduce erosion and sediment runoff.

An effort should be made to split drainage between the Sarasa River and the unnamed stream as close to existing conditions as possible. Fortunately, most drainage associated with the target area is part of the Sarasa system, eliminating the need to have two separate treatment flow paths.

3.2 EW-Alignment – HG Range

The proposed HG Range footprint is located in the STW (**Figure B-13**) to the south of an unnamed tributary of the Sagge River.

3.2.1 Surface Hydrology and Flooding Potential

The proposed footprint receives sheet flow from areas towards the south, and this runoff contributes flow to an unnamed tributary of the Sagge River. Both the unnamed tributary and the main channel are associated with mapped wetlands. There does not appear to be any significant flow gullies or channels running through the footprint (**Figure B-15**). The proposed footprint does not appear to have significant potential for flooding.

3.2.2 Existing Terrain and Grading Issues

The proposed footprint is situated on a south to north oriented finger crest, which terminates along the unnamed stream. The finger crest drops off in elevation toward the unnamed stream to the west, and toward a smaller ravine to the east. As a result, the entire range surface is likely to require excavation or fill. Available topographic data for this area does not exactly match information gleaned from aerial imagery. Cut-and-fill requirements (**Figure B-15**) were estimated based on a desktop evaluation.

3.2.3 Soils

This proposed range rests primarily on Akina-Badlands complex, with some Ylig clay (3 to 7 percent slopes). This soil unit is moderately susceptible to water erosion and is reported to have a moderately slow permeability. Seasonally high water table can exist as close as 25 centimeters from the surface. The soils are very deep, poorly drained, and associated with wetland vegetation.

3.2.4 Site Drainage

Given the footprint's location on the crest of the finger (**Figure B-15**), offsite flows are likely to be very minimal. These could be channeled and diverted around the site via a grassy swale. Onsite flows would need to be captured and detained to prevent unnatural spikes in the runoff hydrograph. The impact area where the grenades would be thrown should be kept clear of potholes and craters.

Drainage from the impact area could be routed through a vegetated swale to a small, constructed wetland basin to help remove any particulates. The rest of the range area could be well vegetated, impervious (structures), or covered with permeable pavement. Only the impact areas for live grenades would need to be cleared and would therefore be susceptible to erosion. Metered release of onsite drainage to the east ravine would be required to prevent unnatural increases in the downstream flow.

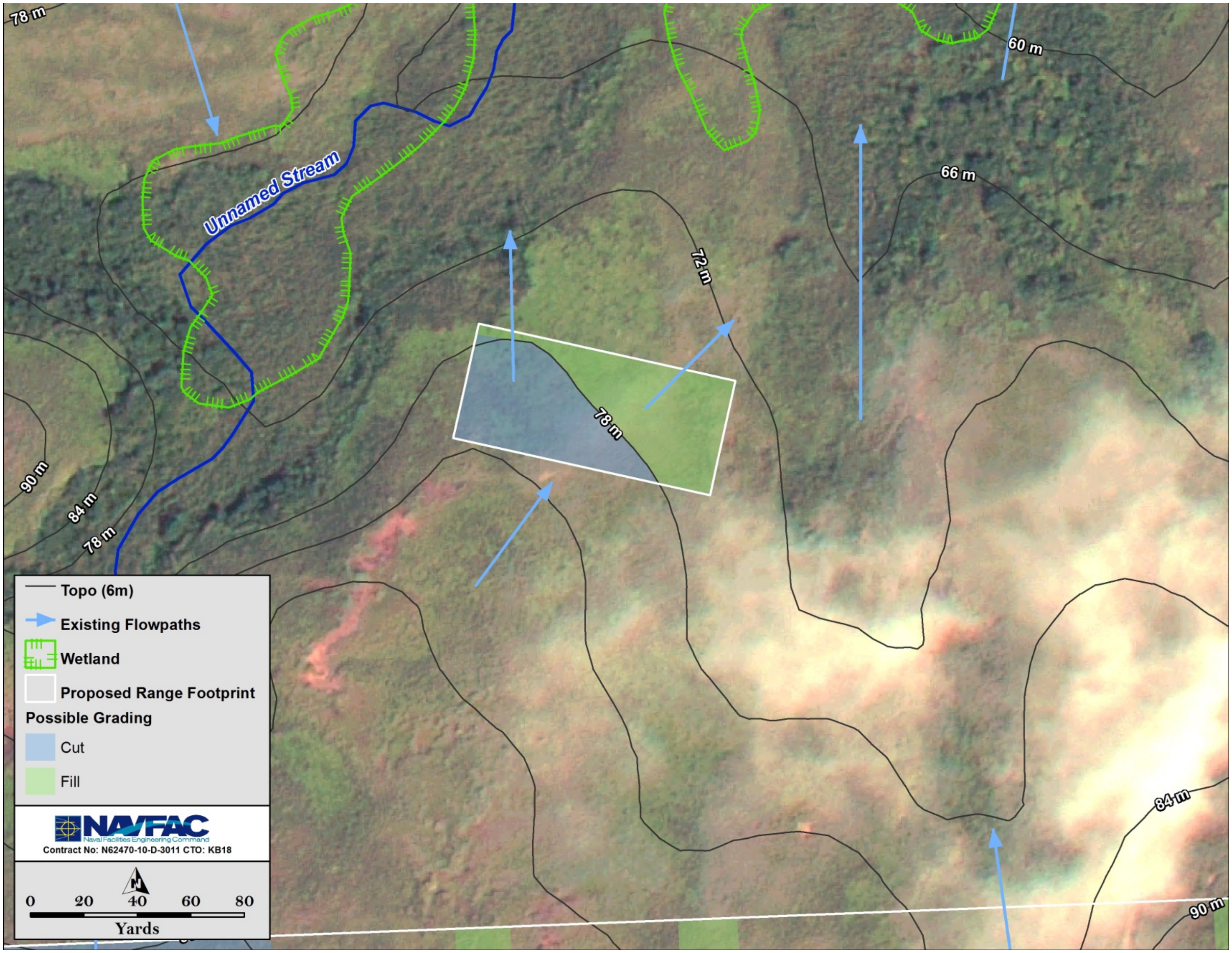

Figure B-15: EW-Alignment HG Range Proposed Footprint –Existing Drainage Patterns and Possible Grading Requirements

3.3 EW-Alignment – Pistol Range

The proposed Pistol Range footprint is located to the north of the proposed MPMG range and upslope of the confluence of the Sarasa and Malaja Rivers (F**igure B-13**).

3.3.1 Surface Hydrology and Flooding Potential

The proposed range footprint rests between the contributing areas of the Sarasa and Malaja River. Runoff from this terrain feature is characterized by sheeting and concentrated flow in localized gullies. The area proposed for the footprint receives sheet flow from a small upslope area (**Figure B-16**); however this is limited by the location along a finger crest. Onsite flows are expected to be minimal and drain either to the north towards the Sarasa River, or to the southeast to the Malaja River. Overall, the proposed footprint does not appear to have significant potential for flooding.

3.3.2 Existing Terrain and Grading Issues

The range is located on a finger which slopes up from the river confluence and towards an area of isolated high ground to the west. While the topographic data indicates that the footprint straddles the crest of a sloping finger, it is likely that the site would need little grading (**Figure B-16**). Most likely, cut and fill volumes would be defined by the need to construct an impact berm, depending upon the type selected.

3.3.3 Soils

This range rests primarily on Akina-Badlands complex. Badlands are prevalent in the adjacent area, as are areas of disturbed and barren soil from past farming activities. Identifying impacts from erosion associated with range construction and operation will be difficult in this area. Runoff and erosion potential are high due to the soil type and barren areas.

3.3.4 Site Drainage

Offsite flows could be diverted around the relatively small footprint area. The topographic data are too coarse and the range footprint too small to determine the need for directing flows into both the Sarasa and Malaja Rivers. Most likely, all onsite drainage could be collected, detained, possibly treated, and released into one river or the other. The footprint's proximity to the confluence of both systems reduces the importance of maintaining the existing flow regime.

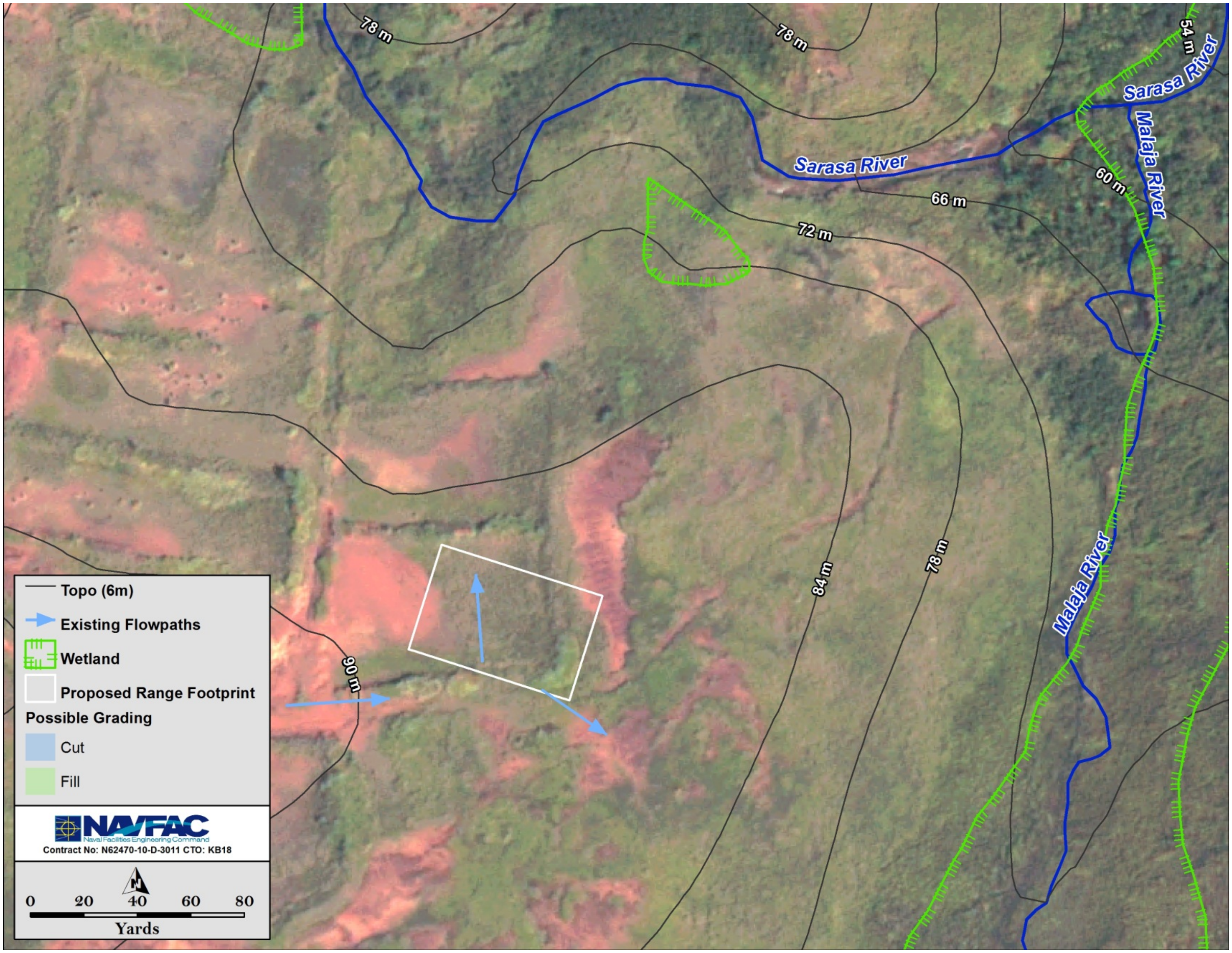

Figure B-16: EW-Alignment – Proposed Pistol Range Footprint Existing Drainage Pattern

3.4 EW-Alignment – Small Arms Range

The proposed Small Arms Range is footprint located entirely within the Ugum Watershed, a short distance upslope from the Bubulao River (**Figure B-13**).

3.4.1 Surface Hydrology and Flooding Potential

The proposed footprint area is located within the contributing area of the Bubulao River. Its location along the slopes above the river appears to be devoid of significant flowpaths of concentrated runoff, rather being drained via sheet flow. Offsite drainage is likely to enter the range footprint primarily from the north, but also from the west and east, with flows converging toward the southern edge of the range to continue down to the Bubulao River (**Figure B-17**). Overall, the proposed range footprint area is not likely to be impacted by flooding.

3.4.2 Existing Terrain and Grading Issues

The existing terrain slopes north to south. The range is oriented east to west across this slope (**Figure B-17**). Substantial amount of cut and fill will be required to provide a level range surface at this location. The required alterations will most likely change the existing drainage patterns in the area.

3.4.3 Soils

The footprint resides exclusively within Togcha–Akina silty clays (3 to 7 percent slopes). With milder slopes, these clays are characterized by a moderate water erosion hazard.

3.4.4 Site Drainage

Offsite drainage will be more significant than those generated onsite. Diverted flows would likely be brought to together at the southern side of the range for reintroduction onto slopes leading down to the Bubulao River. Onsite drainage would have to be collected by vegetated swales and brought to a single location and subjected to a suitable BMP such as a constructed wetland.

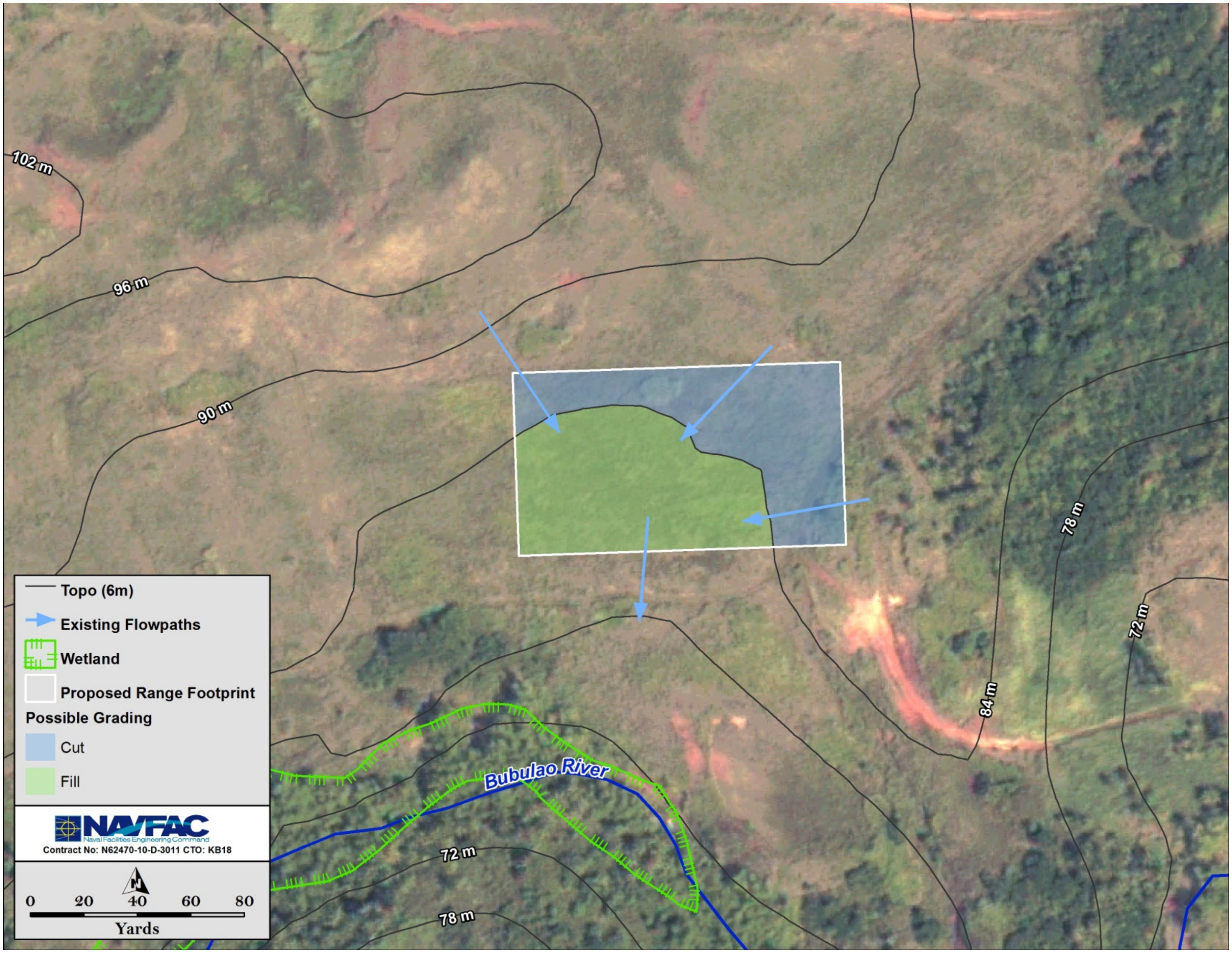

Figure B-17. EW-Alignment Small Arms Range Proposed Footprint – Existing Drainage Patterns and Possible Grading Requirements

3.5 EW-Alignment – MRF Range

The proposed MRF Range footprint is oriented northeast to southwest and is dominated by high ground to the north and its sloping hillside south (**Figure B-13**). A prominent ravine forms below the high ground and out of the sloping hillside, and continues to the northeast. Less prominent ravines slope to two unnamed tributaries of the Sagge River (**Figure B-18**).

3.5.1 Surface Hydrology and Flooding Potential

Existing flowpaths leave the footprint to the north, northeast, and southeast, through three ravines. Offsite flows are likely to only be an issue through the southern portion of the range. Runoff from the existing area within the footprint drains to two unnamed tributaries of the Sagge River, as well as Sagge River proper (**Figure B-18**). At least some of the offsite flow appears to be associated with badlands, which are known to be highly susceptible to erosion. Overall, the proposed range footprint area is not likely to be impacted by flooding.

3.5.2 Existing Terrain and Grading Issues

The footprint is located on high ground which slopes steeply away to the north, northeast, and south. Grade alterations will most likely be needed across the entire range footprint to support a standard MRF range. There is an elevation difference of over 30 feet (10 meters) from the target line to the firing line. From the high ground at the north side of the footprint, the existing terrain slopes to the south, losing approximately 50 feet (16 m) of elevation (**Figure B-18**). The entire footprint would most likely require extensive excavation or filling. Cut-and-fill slopes would be large. Re-vegetating soils after such deep excavations may be difficult in these types of soils. Extensive badlands are present in this area.

3.5.3 Soils

This proposed range footprint is located on top of three soil units: Akina-Badland complex (15 to 30 percent slopes), Akina-Badland complex (7 to 15 percent slopes), and Togcha-Akina silty clays (7 to 15 percent slopes). Togcha-Akina silty clay is 65 percent Togcha clay and 25 percent Akina silty clay. The Togcha soil is very deep and well drained, with moderate permeability and a surface layer of dark red and yellowish red silty clay. The Akina silty clay is also well drained, only moderately deep, and with a moderately slow permeability. Its surface is noted as a dark, reddish brown silty clay. Runoff for both is listed as medium with a moderate water erosion hazard.

3.5.4 Site Drainage

Given the need for large cut and fill slopes, management of onsite drainage is likely going to be challenging at this location. Also, since targets are likely to be scattered throughout the target area, almost all of the onsite drainage will have to be collected and subjected to appropriate BMPs. The multiple flowpaths draining to different streams will need to be considered and may require differing treatments. Offsite flows could be routed via vegetated swales around the range to a constructed wetland that would serve as a detention basin. The wetland would discharge to the unnamed tributary via a controlled outlet to prevent spikes in the hydrograph.

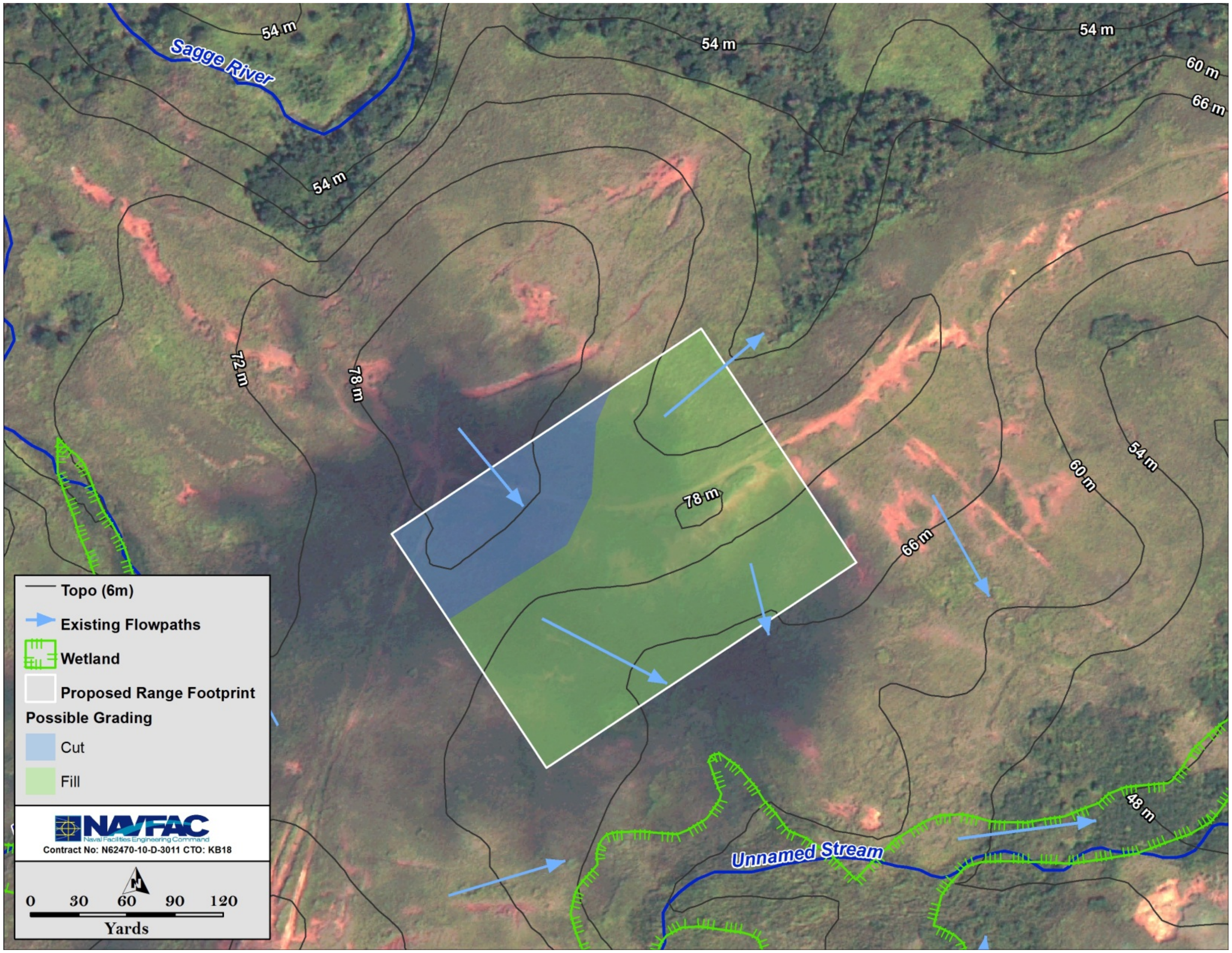

Figure B-18: EW-Alignment MRF Range Proposed Footprint – Existing Drainage Patterns and Possible Grading Requirements

3.6 EW-Alignment – MPMG Range

The proposed MPMG Range footprint is oriented east to west and is located primarily in the southern portion of the Southern Talofofo Watershed, with a small area extending into the Ugum watershed (**Figure B-13)**.

3.6.1 Existing Surface Hydrology and Flooding Potential

Much of the area proposed for this footprint is drained by the Malaja River, which originates in the middle of the proposed footprint and runs east and north (**Figure B-19**). The river ravine also brings offsite flows onto the footprint area in the form of un-concentrated sheet flows. At least some of the offsite flow appears to be associated with badlands that are highly susceptible to erosion. A regular buffer of wetland exists along this stretch of river.

The western portion of the proposed footprint is dominated by two areas of high ground separated by a saddle. This saddle feeds a ravine of mapped wetlands that drains to the Sarasa River. Some areas of the footprint currently drain to the south to the Bubulao River via sheet flow and localized gullies.

As the Malaja River runs through the center of the proposed footprint range for several hundred yards, it is likely that a large portion of the proposed footprint would potentially be inundated under storm conditions. The western portion of the proposed footprint could also experience high water associated with the small ravine wetlands that drain to the Sarasa River.

3.6.2 Existing Terrain and Grading Issues

The eastern portion of the range consists of the sloping ravine forming the headwaters of the Malaja River. The western portion of the proposed footprint is dominated by two areas of high ground separated by a saddle. The most significant grading issue at this location revolves around the 100+-foot (30+-meter) drop between the firing line and the target end of the proposed range (**Figure B-19**). The other challenge will be in dealing with the Malaja River channel, which originates and then runs through the middle of the proposed footprint.

Some excavation at the target end of the range could lower the elevation and eliminate some of the line-of-sight concerns. This fill could be used to construct an impact berm and a raised firing position. Much of the middle of the range would not need substantial alterations.

An end-of-range containment berm would help reduce ricochets leaving the range, but would probably not provide complete containment. Unknown-distance shooting with multiple targets scattered through the target area makes for a higher likelihood of short rounds and therefore a higher risk of ricochet. Targets located midrange would likely cause ricochets not contained by an end-of-range berm. Localized berms behind targets may be a better option and could be used in addition to an end-of-range berm. Additionally, target material will be an important consideration in an attempt to reduce ricochets.

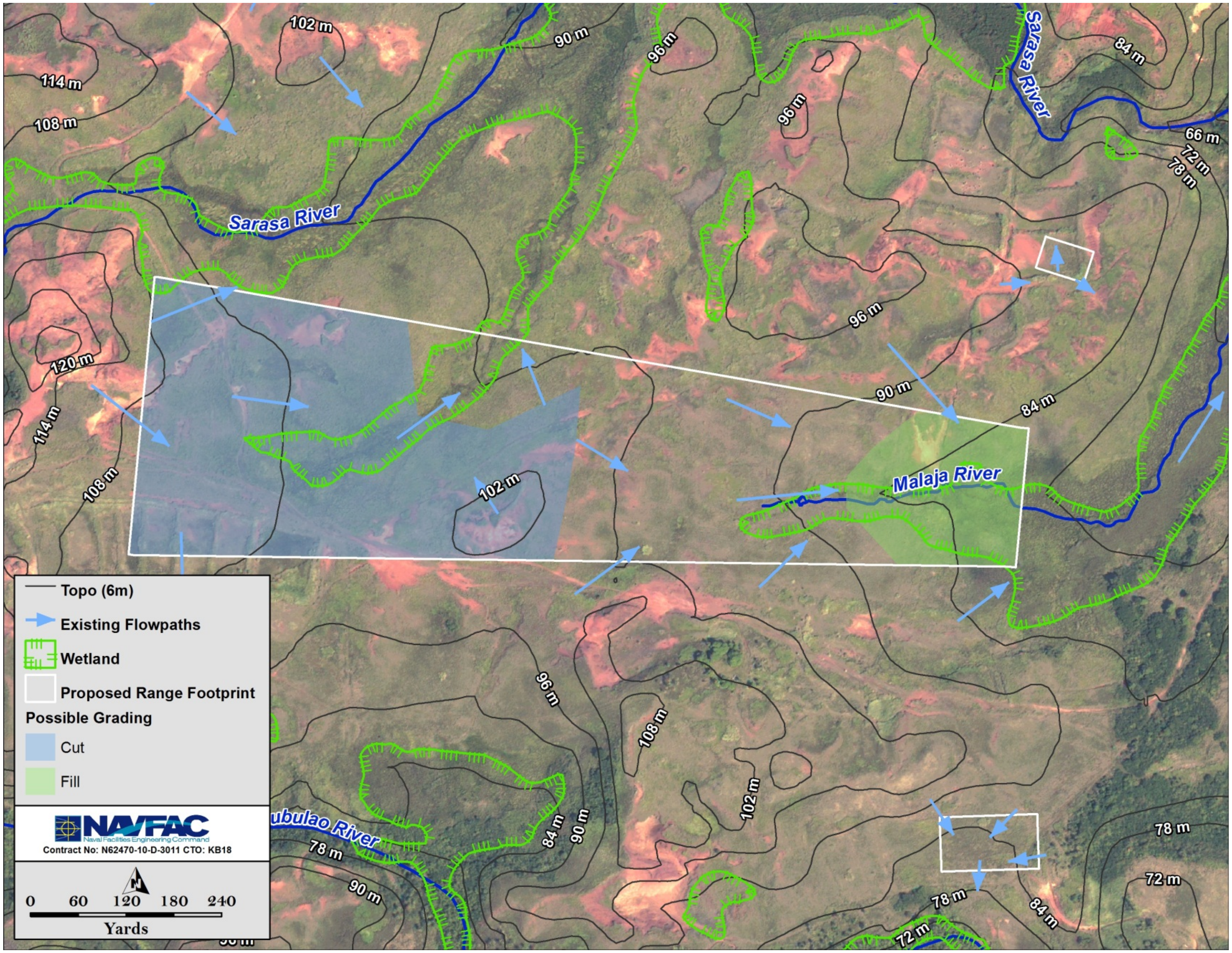

Figure B-19: EW-Alignment MPMG Range Proposed Footprint – Existing Drainage Patterns and Possible Grading Requirements

3.6.3 Soils

The soils in this area are a mixture of Togcha–Akina silty clays (3 to 7 percent slopes), Akina-Badland complex (7 to 15 percent slopes), and Ylig clay (0 to 3 percent slopes).

Relevant properties of Togcha–Akina silty clays and Akina-Badland complex have been previously described (**Section 2.5.2**). The Ylig clay (0 to 3 percent slopes) is moderately susceptible to water erosion and is reported to have a moderately slow permeability. Seasonally high water table may exist as close as 25 centimeter from the surface. These soils are very deep, poorly drained, and associated with wetland vegetation.

3.6.4 Site Drainage

The presence of the Malaja River within the footprint poses the most significant challenge for this proposed footprint. There does not appear to be an easy option to re-route or shift the river channel. The firing line would completely fill in the channel, so culverts would be needed to pass the flows underneath the proposed range. Once the Malaja River is adequately addressed, additional offsite flows could be routed around the range using standard techniques.

The increased chance of lead dispersion within the target area due to multiple unknown-distance targets used at this type of range increases the importance of capturing and treating onsite runoff prior to discharge. An option could be to locate all targets towards the far one-third of the range, which may reduce the amount of potentially contaminated runoff. Also, since the firing line and the target area are separated by some distance, separate swale and detention pond systems could be used to contain and treat the flows prior to discharge.

4.0 L-ALIGNMENT

The L-Alignment MPMG Range is located in the NTW. Four others are located in the STW, and the sixth one is located in the Ugum Watershed (**Figure B-20**).

4.1 L-Alignment – KD Rifle Range

The proposed range footprint is oriented east to west and is located along the Talofofo-Ugum Watershed divide (**Figure B-20**).

4.1.1 Surface Hydrology and Flooding Potential

This area predominately drains to the northeast via a ravine and a mapped wetland towards the Sarasa River. The ravine collects runoff from the western, northern, and eastern areas of the footprint (**Figure B-21**). A small portion of the footprint drains south towards the Bubulao River. Offsite drainage would enter the proposed range from the higher grounds to the west. Extensive badlands are present and therefore it is likely that offsite flows may contain high levels of eroded material. Flow rates are likely to be high due to due to the lack of vegetation. Flooding through the central ravine is possible; however possibility of operational impacts is low.

4.1.2 Existing Terrain and Grading Issues

The higher ground of the firing end and target end of the range are separated by the drainage ravine through the middle. With the exception of this ravine, the range is fairly level east to west and north to south (**Figure B-21**). Some grading may be required in selected areas.

4.1.3 Soils

The soils are a mixture of Togcha–Akina silty clays (3 to 7 percent slopes), Akina-Badland complex (7 to 15 percent slopes), and Ylig clay (0 to 3 percent slopes). Runoff and erosion potential ranges from moderate (Ylig and Togcha Akina) to high (Akina-Badland complex).

4.1.4 Site Drainage

Offsite flows originating from the west of the proposed footprint (and flowing towards the proposed target area and impact berm) will have to be managed at this location. These flows could be collected via a vegetated swale and routed into a strategically located constructed wetland/detention basin. Due to the existing central ravine, which is likely to receive metered flows from the constructed wetland, the basin could be sited between the target line and the 200-yard firing line. Likely impacts on the wetland located in close proximity of the central ravine will have to be evaluated and mitigated as necessary. The runoff carried by the central ravine would need to be passed under the 200- and 300-yard firing lines. Soft-bottom, arched culverts could be designed to handle these flows with minimal impacts to the channel bed and to ensure no unnecessary increases in local flooding. Areas between the target line and the three main firing lines could be allowed to drain off the range naturally. These areas are likely to see minimal impacts from construction and operation. Planting could be used to reduce erosion potential in this area.

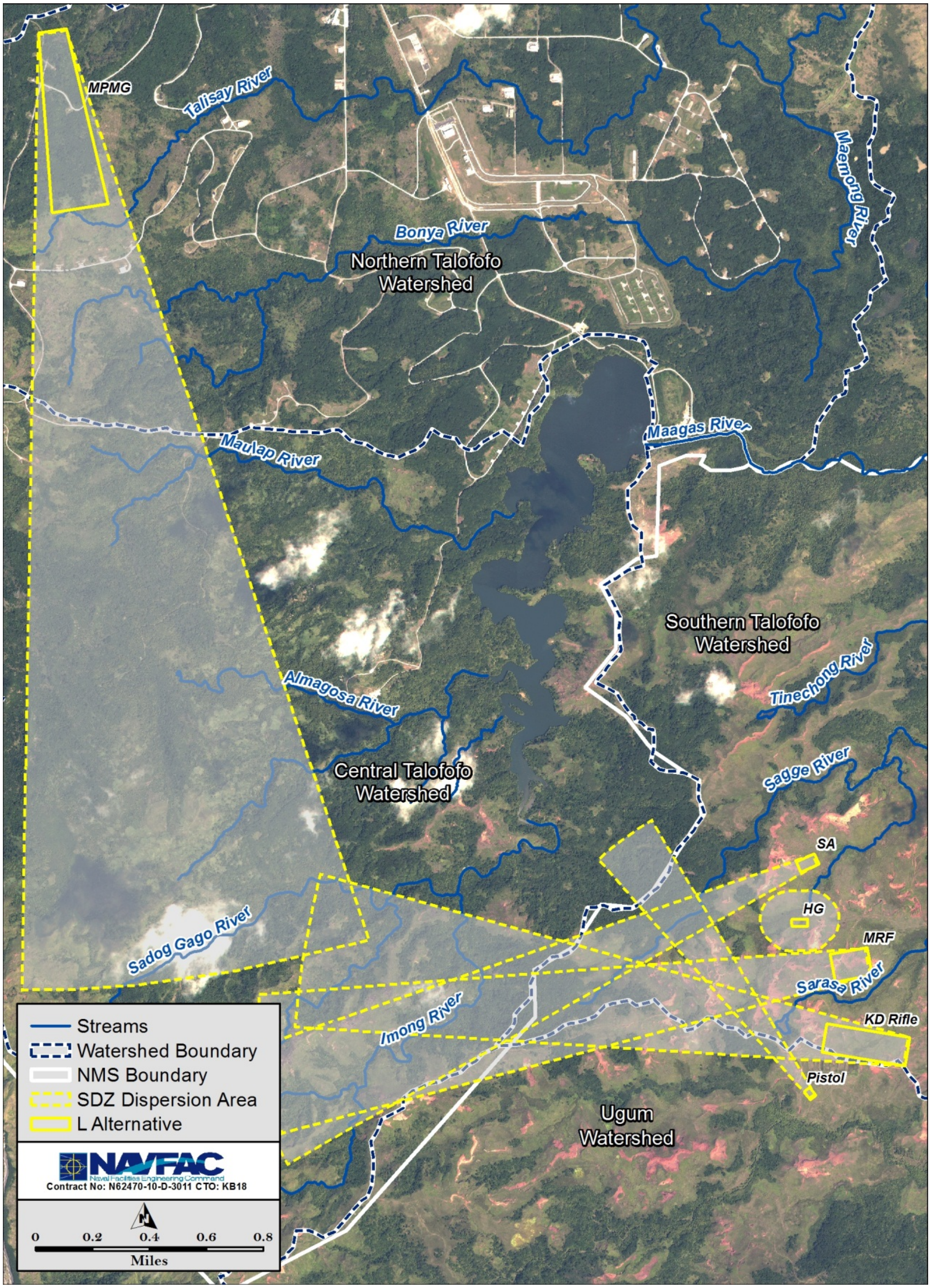

Figure B-20: LFTRC L-Alignment Proposed Range Footprints

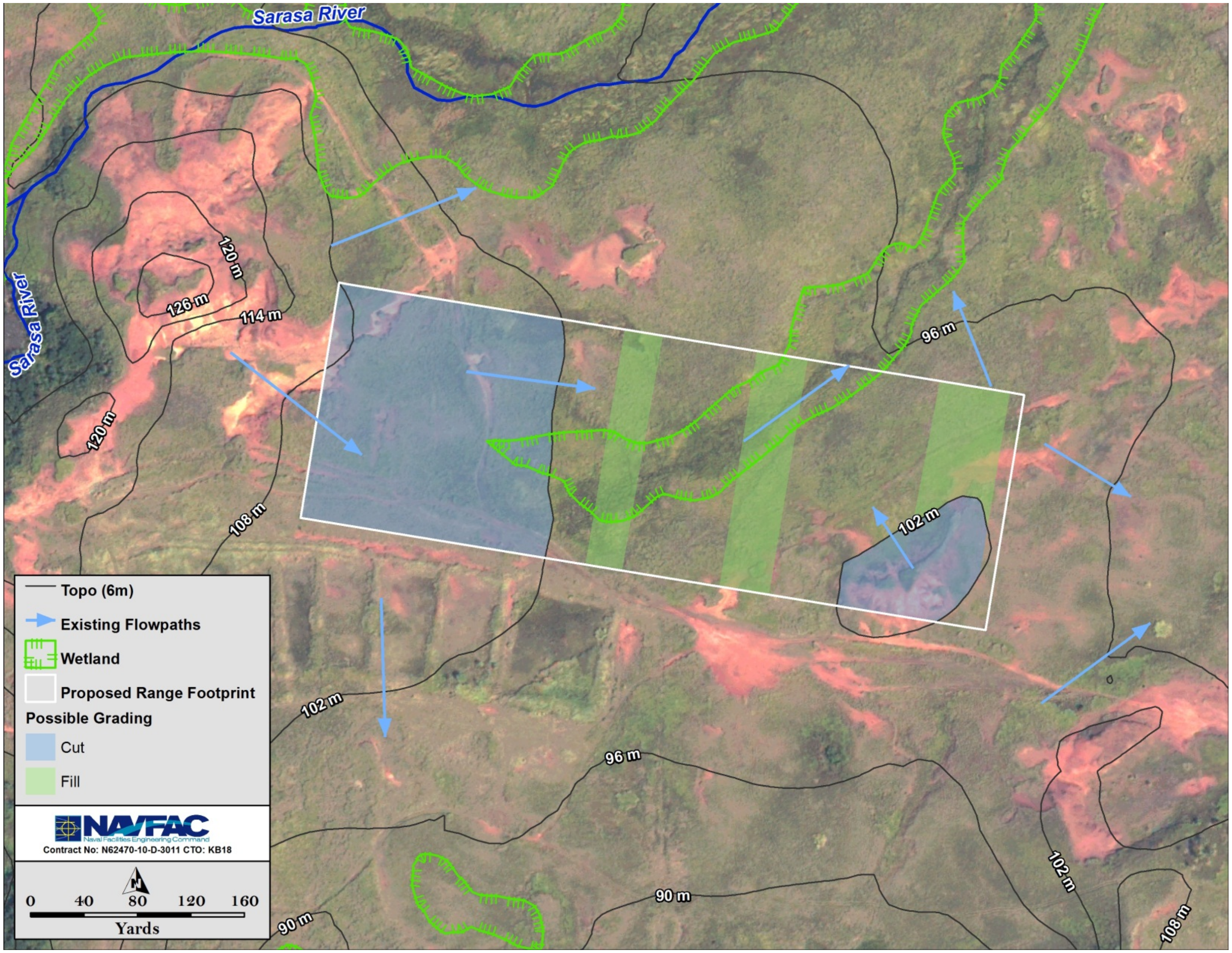

Figure B-21: L-Alignment KD Rifle Range Proposed Footprint – Existing Drainage Patterns and Possible Grading Requirements

4.2 L-Alignment – Small Arms Range

The proposed Small Arms Range footprint is located in the southern Talofofo Watershed (**Figure B-20**) on the eastern slope of a hilltop dominated by extensive badlands (**Figure B-22**).

Figure B-22: Representative Photo of Typical Badlands in the Southern Talofofo Watershed

4.2.1 Surface Hydrology and Flooding Potential

The proposed footprint area is located upslope and to the east of the Sagge River. Runoff from the site enters one of the tributaries of the Sagge River (**Figure B-23**). The proposed range footprint appears to be located across a gully which carries runoff from the described badland areas.

The proposed footprint and adjacent areas are dominated by savanna grasslands and badlands, both of which are characterized by high erosion potential. The proposed footprint area appears to be located sufficiently upslope to avoid direct flooding impacts from the adjacent Sagge River tributary; overall, flooding potential therefore appears to be low at this site.

4.2.2 Existing Terrain and Grading Issues

Some cut and fill would be required to level the slope (**Figure B-23**) within the proposed footprint. Additional earthwork will be required to deal with offsite runoff originating in the upslope badlands.

4.2.3 Soils

The proposed range footprint is located primarily on Togcha-Akina silty clays (7 to 15 percent slopes) with moderate risk of water erosion. The areas upslope of the range footprint are dominated by Akina Badland complex. Runoff is rapid for this soil types and the risk of water erosion is severe.

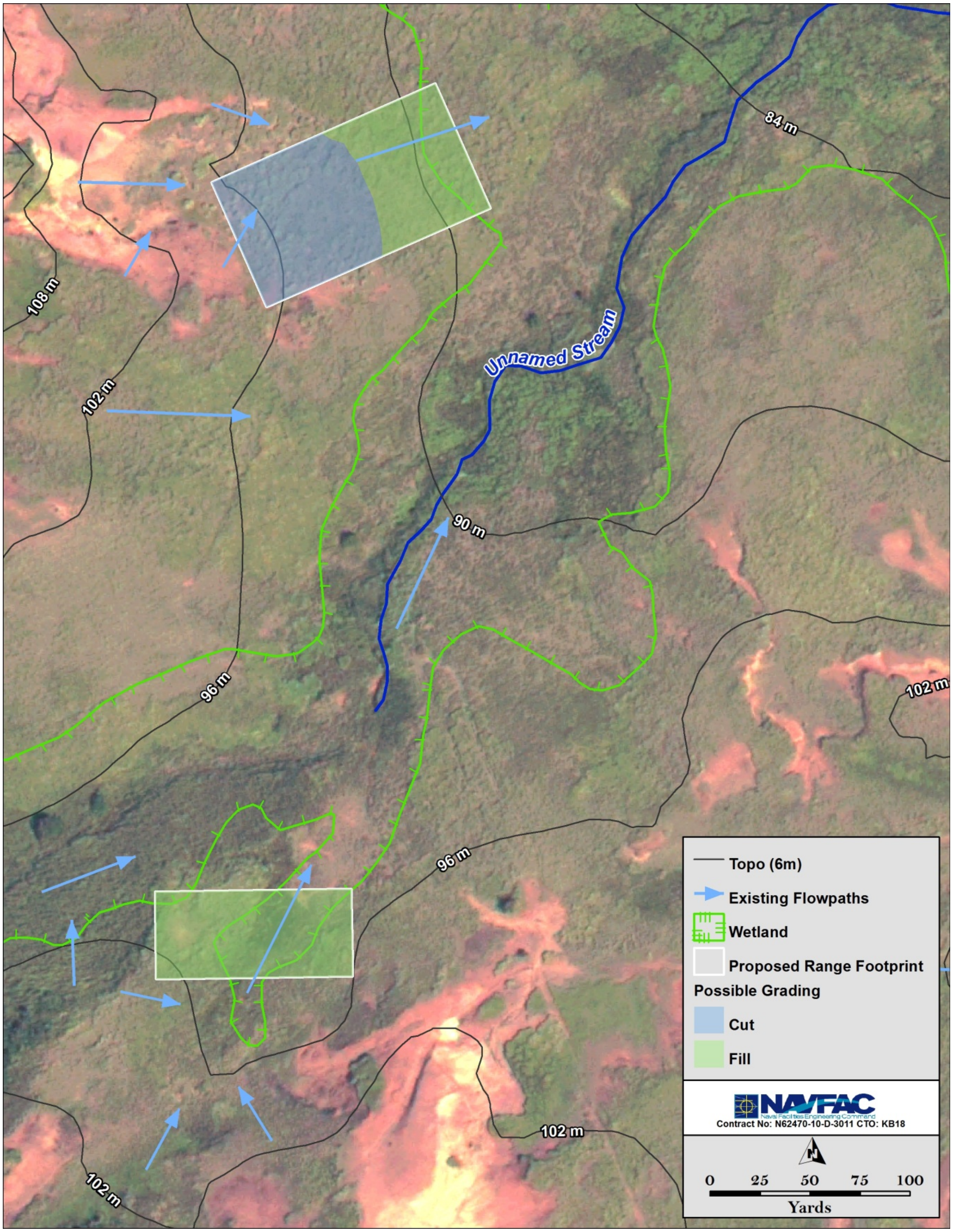

Figure B-23: L-Alignment Small Arms (above) and HG (below) Ranges Proposed Footprints – Existing Drainage Patterns and Possible Grading Requirements

4.2.4 Site Drainage

Onsite flows from un-impacted area on the proposed range will have to be detained and metered into the local drainage system to prevent unnatural spikes in the hydrograph. Drainage from the impacted area could be routed through a vegetated swale to a small, constructed wetland basin to help remove any particulates. The proximity of the stream raises the risk of munitions constituent migration off of the range, be it via surface water during catastrophic flooding events (common during typhoons) or migration through groundwater.

4.3 L-Alignment – HG Range

The proposed HG Range footprint is located in the Southern Talofofo Watershed (**Figure B-20**) immediately adjacent to an unnamed tributary of the Sagge River.

4.3.1 Existing Surface Hydrology and Flooding Potential

The proposed range footprint is located towards the bottom of the hillside sloping down towards an unnamed stream. It is likely that the proposed footprint encroaches into the active stream channel, especially during high flow events. Areas upslope of the proposed footprint are characterized by extensive badlands.

Substantial amounts of offsite flow most likely drain towards the proposed footprint from the south and east. Additional offsite drainage from the unnamed stream will also have to be accounted for in the range design. On-site flows currently drain directly to the wetland buffer around the stream channel. Much of the proposed footprint is located within this buffer wetland. Overall, flooding appears to be a significant risk to the constructed facility and range operation in this location.

4.3.2 Existing Terrain and Grading Issues

The proposed footprint slopes south to north towards the target area (grenade throwing direction) (**Figure B-23**). It is likely the majority of the footprint is flat, with only the western and eastern edges sloping upward. The proposed footprint's proximity to the stream and its location within wetland habitat necessitate the entire footprint be raised with fill. This encroachment within the active channel will require engineered protection (structural or bio-engineering) for both the developed range and the health of the stream channel. Alterations within an active stream channel may face substantial permitting hurdles (USACE Section 401 and 404 permits).

4.3.3 Soils

Soil within the footprint boundary is listed as Ylig clay (3 to 7 percent slopes), which is moderately susceptible to water erosion and is reported to have a moderately slow permeability. Seasonally high water table may exist as close as 25 centimeters from the surface. These soils are very deep, poorly drained, and associated with wetland vegetation.

4.3.4 Site Drainage

Offsite drainage originates upslope in the areas of extensive badlands. Sheet flow off of these badlands likely accumulates rapidly into larger gullies as it traverses down slope. One particularly large gully appears to drain through the center of the range footprint. This offsite flow path will likely require a designed channel or culvert system to pass flow through the range.

Adverse impacts associated with offsite drainage resulting from higher flows in the stream and wetland could be minimized by raising the elevation of the range. However, this will increase the footprint of the range, as well as the encroachment into the active flow channel.

It appears that there is not much room available at this location to create a detention basin or a constructed wetland to hold onsite drainage. The area to the north could potentially be used to locate a structural BMP. The proximity of the stream raises the risk of munitions constituent migration off the range, be it via surface water associated with catastrophic flooding events (common during typhoons) or migration through groundwater.

4.4 L-Alignment – Pistol Range

The proposed Pistol Range footprint is located in the Ugum Watershed (**Figure B-20**) and it is oriented to the northwest.

4.4.1 Existing Surface Hydrology and Flooding Potential

The proposed footprint is located upslope from the Bubulao River and is situated below the crest of a hill protruding into the river basin (**Figure B-24**). Runoff begins as sheet flow, which accumulates in rivulets and gullies. The flows concentrate towards the bottom of the slope and enter into an isolated wetland north of the Bubulao River. This wetland is most likely influenced by the Bubulao River and most likely receives substantial flows from the river during peak storm events. Overall, given its location the proposed footprint is unlikely to experience substantial flooding.

4.4.2 Existing Terrain and Grading Issues

The area of the proposed footprint itself appears relatively flat. The coarseness of the topographic data and the small size of the proposed range preclude meaningful estimations of cut and fill volumes. The greatest component of earthwork required at this site could possibly stem from constructing an impact berm.

4.4.3 Soils

The soils throughout the footprint are Togcha-Akina silty clays. Runoff and erosion potential are moderate.

4.4.4 Site Drainage

Offsite flows would be routed around the range to the south fairly easily. The small quantity of the flows will allow for a smooth re-introduction onto adjacent slopes, where this flow will continue down-slope to the wetland area. Onsite flows could be collected via vegetated swales and brought to a basin to allow for a metered release of flows.

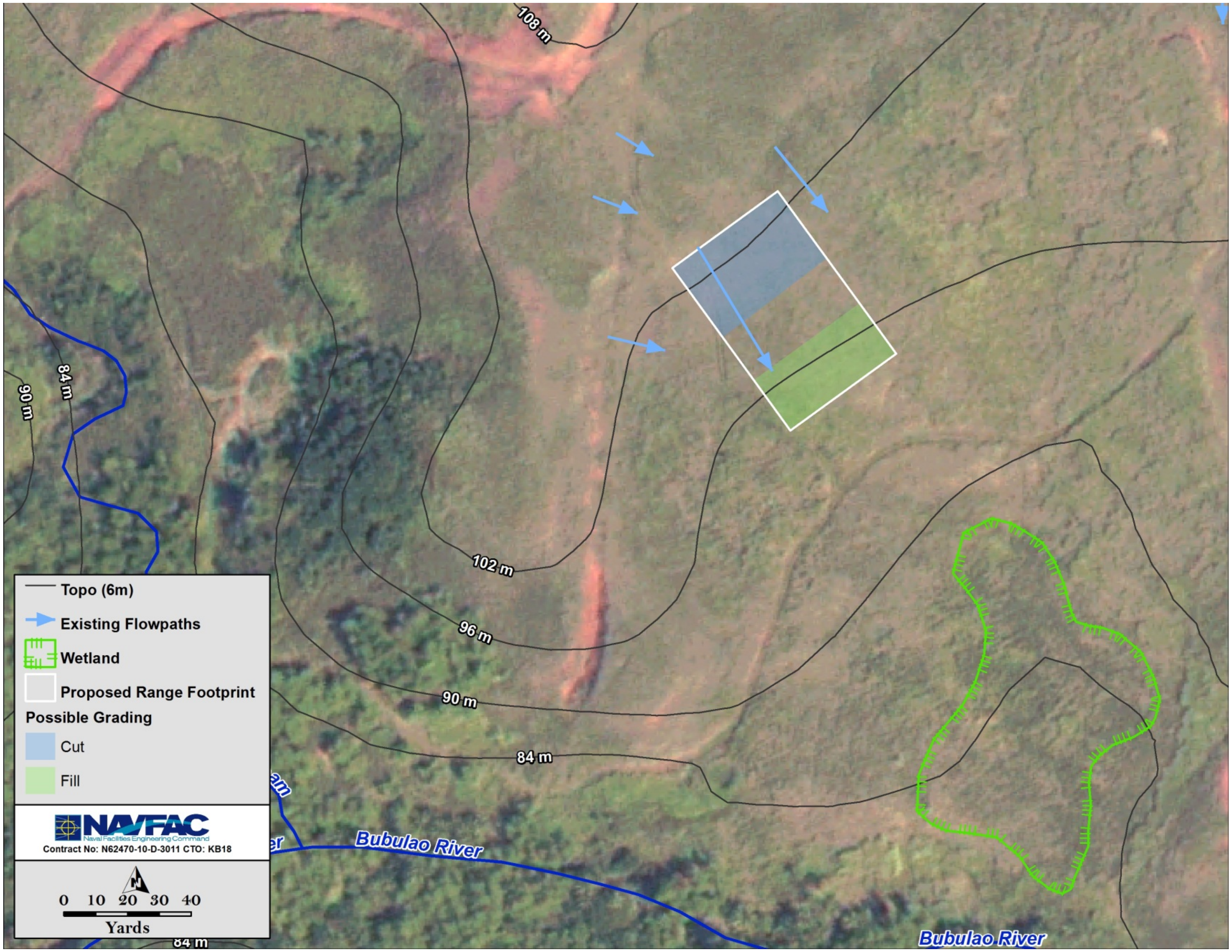

Figure B-24: L-Alignment Pistol Range Proposed Footprint – Existing Drainage Patterns and Possible Grading Requirements

4.5 L-Alignment – MRF Range

The proposed MRF Range footprint is located in the Southern Talofofo Watershed (**Figure B-20**) on relatively flat terrain.

4.5.1 Surface Hydrology and Flooding Potential

The proposed range is located within the contributing area of the Sarasa River, with multiple flowpaths leading to different reaches of the river. Offsite flows, most likely originating from the higher grounds that are scattered with badlands and improved roads, converge towards the proposed footprint area from the north and west. The flows drain into the wetland surrounding the Sarasa River. The proposed range footprint is located mainly on elevated terrain and therefore has relatively low flooding risk.

4.5.2 Existing Terrain and Grading Issues

This range is located on fairly flat terrain (**Figure B-25**). The primary need for grading at this location would be to eliminate line-of-sight concerns. The nature of this range allows for some undulation in terrain. The range could potentially be constructed with only localized earthwork.

4.5.3 Soils

The proposed range footprint is characterized primarily by Akina Badlands complex of various slopes. Soil erosion potential is high, as confirmed by the numerous badlands and 7 to 15 percent slopes.

4.5.4 Site Drainage

Offsite drainage would most probably be an issue only towards the target end of the proposed range (west) and along the northern edge (**Figure B-25**). These flows would have to be channelized, routed around the range to the north or both sides of the range, and returned to the natural drainage pattern of the area.

Onsite drainage would be collected and treated according to its potential for contamination. Flows would have to be channeled through vegetated swales into a detention basin/constructed wetlands and discharged into the local drainage system in a managed manner. Target area drainage could be routed through additional BMPs. Sufficient area exists to the east of the footprint to provide detention within a constructed wetland.

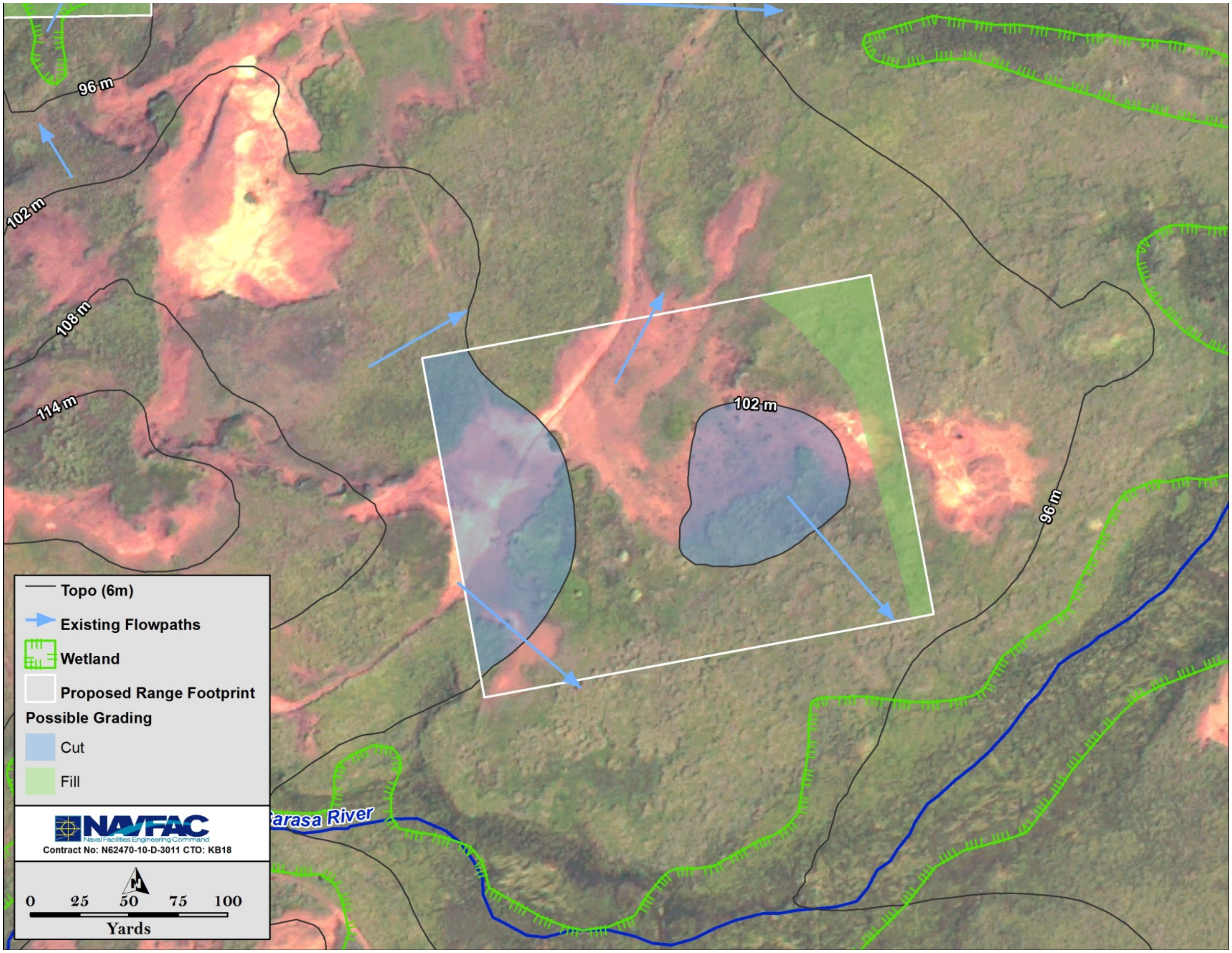

Figure B-25: L-Alignment MRF Range Proposed Footprint –Existing Drainage Patterns and Possible Grading Requirements

4.6 L-Alignment – MPMG Range

The proposed MPMG Range footprint is located in the NTW (**Figure B-20**). Relevant information on surface hydrology, flooding potential, soils, and drainage issues associated with the proposed MPMG Range was previously discussed in **Section 1.6**.